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ABSTRACT

This collection of 33 conference papers and 10 abstracts provides a critical assessment of the current applications of interactive multimedia in museums, an analysis of museum requirements, and an exploration of technology issues. Two papers discuss the parallel attributes of museums and software technology and the possibilities of the virtual museum. Eight papers address issues of design, evaluation, and implementation. Separate papers present hypermedia projects in 11 different museums. Three papers address issues raised by wordless communications, including images and full body interactives. Three more papers explore issues of copyright and the difficulties in satisfying intellectual property claims of owners and creators of the components of multimedia products. Technological barriers to implementing hypermedia in museums are addressed in five papers, including the poor visual quality of most media products, the need to "scale up" existing prototypes to express cultural knowledge bases and the costs of doing so, and the need for standards for the use of electronic records that will facilitate access to and reuse of information. Abstracts of or brief communications relating to 10 additional conference presentations are also provided. (KRN)

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HYPERMEDIA & INTERACTIVITY IN MUSEUMS

Proceedings of an International Conference

Edited by David Bearman

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Interactive and Hypermedia in Museums

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Introduction

This volume is both the record of a conference and the first monographic publication devoted to interactive and hypermedia in museums. It is a great pleasure to be writing the introduction to a book of essays which contains so many important papers and which is addressed both to museum professionals interested in applying the technology and to interactive media developers interested in serving museum requirements. For several years I have looked forward to a meeting that could advance the state of the art by critically assessing current applications of interactive multimedia in museums, analyzing museum requirements and exploring technology issues. In this volume, and the conference whose Proceedings it represents, we have just such a critical perspective.

The organization of this volume does not follow the organization of conference sessions, nor do the contents represent all of the nearly 100 papers presented at the meeting. Instead, the papers are organized into five general sections: the Changing Museum, Museum Issues, Museum Projects, Broader Cultural Issues and Technological Issues. These sections are followed by a section of abstracts of some additional papers presented at the meeting. Papers in both the Museum Projects and the Abstracts sections are presented in alphabetical order by lead author. In the other sections they are organized thematically.

It goes without saying, especially at a meeting devoted to the concept of interactivity, that these static reports cannot convey all the excitement of the ICHIM conference, nor can their poor black and white photographs leave more than the faintest impression of the programs that were presented. Nevertheless, I hope that as readers study these papers they will find in them greater depth, and take from them stimulating ideas. In true self-exemplifying fashion, these Proceedings illustrate again that the best of all possible worlds is to both experience the original thing, and have the opportunity to study the surrogate.

I. The Changing Museum

Museums provide an opportunity to interact with artifacts, specimens, and realia from beyond our everyday experience. Their holdings include that which is unique, remote, or difficult to perceive, and are therefore exhibited to us with interpretive text, images and sounds. The museum is a multimedia experience. Since the early 20th century museums have strived to be more than "cabinets of curiosities" to be viewed passively. In this volume we witness the latest efforts to interact more assertively with visitors, but despite the introduction of a new technology, they represent a continuity more than a radical departure.

Stephen Alsford finds the technology of hypermedia is a metaphor for the museum. He doesn't have to reinvent the museum or change its course to tease from its methods the concepts of branching and linking and user driven navigation. Museums have these attributes. What is new is a software technology which behaves in many ways like the museum should, and does, at its best.

Indeed, this technology behaves like a museum without requiring the infrastructure of the museum. It can enable explorations of the unique, the remote and the difficult to perceive, which can take place in a school, in the home or on the street as easily as in the museum itself. In their thoughtful exploration of these possibilities, Dennis Tsichritzis and Simon Gibbs discover the "virtual museum", and in so doing force the real museum to define itself and its special role in preserving and studying material objects of our culture and of the natural world. Others are taking up the challenge of the virtual museum as an institution better suited to the handicapped and aged that the "real" museum, as reported by Margareta Jaric during the ICHIM conference.

II. Museum Issues

Whether hypermedia will be the museums of the future, and/or whether museums of the future will use interactive and hypermedia to augment the experience of real things along with interpretive drama, multimedia exhibitions, and textual labels, as they now do, will depend on the resolution of outstanding cultural and technical issues.

Can we design hypermedia that visitors will want to explore? Kathleen Wilson presents some of the groundrules for such designs and data to suggest that they might work, but what kind of institution will people come to in order to have in-depth experiences of the kind she describes? Will these be museums?

John Driscoll examines a way to make these experiences as attractive as television and other entertainment that our visitors have come to expect. We may not be able to afford this luxury, but if we can, will the museum experience be in some way different from that of a theater?

The ultimate challenge is to transport the interactive multimedia museum not just outside its walls, but where there are no walls. Katherine Woolsey and Robert Semper explore such extensions of multimedia into public spaces and identify the design problems that must be overcome to make such new realities effective. One issue we will certainly need to address is how to make interactive experiences meaningful for groups rather than only for individuals.

Some of the answers, I believe, will be revealed by rigorous evaluation of our hypermedia and interactive products in their installed settings. The papers by David Allison, Tine Wanning and Andrew Peterson should improve the questions we ask. Wanning makes it clear why we need to begin by asking ourselves what we know about our visitors and their interests before selecting materials and presentation methods, and how we can then study user reactions by administering simple questionnaires. Allison introduces us to the enormous potential for visitor monitoring that is inherent in interactive multimedia and illustrates how this is being taken advantage of in the massive "Information Age" installation at the Smithsonian. Peterson presents an intellectual framework for the evaluation of interactive and hypermedia based on psychological models and educational technology standards. Without such models of what we are trying to achieve, evaluation will be an empty exercise.

Even the best designed programs must be implemented in such a way that they will work, and will continue to be working, for visitors. Jim Oker distills many years of experience in making reliable interactive multimedia in his paper. One hopes that his advice will be taken.

III. Museum Projects

Even though many design and evaluation issues remain unresolved, brave museum educators and collections managers have taken the plunge. In the section on Museum Projects we encounter an array of projects differing widely in their intentions and their approaches. Several take up a theme enunciated by Selma Thomas, that the museum interactive project should enhance the public experience of the museum collection. Thus Deborah Cooper and Jim Oker see the History Information Stations at the Oakland Museum as places where the visitors can take off from the collection, and John Loven emphasizes the ways in which museum visitors can see a kind of collection that is difficult to explore except through media since boats and ships are notoriously cumbersome to display.

But other museum projects take quite a different tack. Jim Hoekema and Peter Lewis describe products for the visitor to take home, not so much to enhance the experience of the collection as to extend it. Deborah Howes and Howard Litwak describe products that are experiences in themselves, valid independently of the exhibits in which they reside. Certainly such an independent experience is at the heart of the theoretical concerns confronting Nobuyuki Ueda and Mark Gross as they seek a definition of the NeoMuseum.

Harrison Eiteljorg and Larry Friedlander go a step further in seeking to create experiences of other worlds with scholarly tools rather than exhibit artifice, but seek as well by building complex databases to achieve a holistic perspective from which the past can be viewed, analyzed and understood, if not experienced. Richard Llewellyn describes a contrary tendency, to use multimedia and imaging technologies to describe objects in the custody of the museum, not for public interpretation, but for staff use.

Each project, of course, was planned and implemented in a unique management context. Each, we would hope, formulated objectives and strove to realize them by their designs. What they have in common is the need to develop appropriate content, to select appropriate delivery technologies, and to deploy the installation in an appropriate venue, which is the broadest kind of user interface consideration. They have this in common because they are applications, and it is as applications that we must gauge their success, not as pure designs, or clever implementations, or gripping content.

And interactive multimedia has too often come up short when assessed as applications because so often the authors are intent on breaking through a technical barrier, or plunging into new cultural domains, rather than contributing to the museum.

IV. Broader Cultural Issues

How often do we tell ourselves that a picture is worth a thousand words? We assure ourselves that images are a universal means of communication which will enable us to carry our message across different age groups, cultural groups, and languages. It is therefore an extremely useful corrective that Chantal Cornuejols and Kathryn Murphy-Judy deliver in exposing just how learned our understanding of images is, and how radically the thousand words conveyed by an image will differ depending upon the cultural experience of the viewer.

Matthew Hogan, Corinne Jorgenson and Peter Jorgenson suggest that some of the cultural bias of images can be controlled, as vocabularies can be controlled, through hierarchical thesauri. Their proposal for a true visual thesaurus however takes the concept of image recognition in information retrieval applications far beyond where it has been to date.

If still images can convey meanings so diverse, imagine the potential meanings attached to body language in the full-body interactive exhibit. Myron Krueger, in his provocative keynote presentation to the ICHIM conference, suggested that such full body interactives could become vehicles for communication in our future culture. They could certainly transform our experience of museums.

Communication problems of a different sort impede our development of interactive and hypermedia for public use; these are the difficulties we encounter in satisfying intellectual property claims of the owners and creators of the media components of our multimedia products. The problem is universal, so it is appropriate that it was addressed here by a Dane, and American and a Briton who barely drop a stitch between their respective papers. The scope and character of the problems of intellectual property are first deftly sketched by Peter Looms. Nathan Benn explains why copyright had become such an issue in multimedia publications since the advent of optical discs, and how it is likely to become more of a barrier unless approaches in which rights holders are justly remunerated can be made to succeed. He proposes a rights collective, which is part of the proposal made by Jeremy Rees and the European Visual Arts Network, but Rees goes beyond simply positing a collective, to outline plans for full scale collaborations between all the parties.

V. Technological Issues

If the cultural barrier to acceptance of copyright for digital media can be overcome through collaboration and broad cultural re-education, there will remain numerous technological barriers to full implementation of interactive and hypermedia in museums.

Until recently the most serious of these barriers was the poor visual quality of most interactive and multimedia products. For a community which prides itself on connoisseurship, television quality images, and even images displayed on high end engineering workstations, were simply inadequate to convey the detail and the richness of color in unique objects of great cultural value. As the team of Biribeau, Taylor, Rioux and Godin point out, research has progress significantly in the past decade. Some art historians, such as Anthony Hamber, are now able to explore the potential of such high resolution images thanks to support from the European Economic Community and others for projects like VASARI. We can almost certainly expect the quality issues to be resolved soon, and costs associated with high quality to fall dramatically in the near future.

If only we could be equally sanguine about the problems associated with scale. Robert Glushko exposes what we alert observers have vaguely known; hypertext and hypermedia projects to date are largely prototypes for the great cultural knowledge-bases on which so many of our visions of the future depend. Like so many prototypes they will not scale up easily, if at all. Peter Looms returns in a second article to explore in detail the economic and design implications of scaling up, and leaves us properly concerned.

Last, but hardly least, the barriers to adoption of interactive and hypermedia in museums are the absence of standards. These barriers will inhibit the development of a consumer market, which will dampen museum enthusiasm for such projects and keep the costs of implementations higher than they would be with a vibrant consumer market. Incomplete standards will have a greater impact on museums however because museums cannot afford to recapture, and recreate, their information about their holdings on a continuing basis. Information about museum collections is a valuable resource, gained at considerable cost over many years as prudent museum administrators recognize. It is therefore heartening that Judy Moline concludes this volume with a blueprint for using standards already in place to achieve reasonable stability in multimedia resources. Only with such stability at a technical level can the re-use of resources take place.

This volume, like the conference which it reflects, presents the best thinking worldwide about a complex subject. If it leaves readers with no simple answers, it is because there are none. Interactive and hypermedia holds tremendous promise for museums if good design and evaluation can be tied to visionary objectives and well conceived applications, but the broader culture and the technical milieu constrain us, and smart museum professionals will take these constraints seriously while striving to overcome them.

Acknowledgements:

I would be remiss if I did not take the opportunity here to thank the Conference Organizing Committee for their assistance and support: Peter Homulos (Canadian Heritage Information Network), Carsten Larsen (National Museums of Denmark), Alan Newman (Art Institute of Chicago) and Isobel Pring (Digital Vision, UK) assisted in lining up the speakers whose papers are represented here and reviewing their preliminary proposals to participate.

I would also like to thank George Haynes for his overall help in getting the meeting off the ground and Corinna Burns who spent the summer actually compiling this volume.

Museums as Hypermedia

Interactivity on a Museum-wide Scale

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Good management begins with planning, and at the foundations of planning must lie an understanding of the nature of the institution: what its role is in society and how it goes about fulfilling that role. In my own institution, the Canadian Museum of Civilization (CMC) the driving vision of the Director, George MacDonald, was crucial to the project, during the '80s, to create a new museum responsive to the needs of the society it must serve. Of course, a guiding vision is not by itself enough; you must also instil it into the corporate culture. But I do not wish here to address practical issues such as getting management to "buy in", communicating the vision to staff, and ensuring fiscal and other resources are sufficient to achieve the goals implicit in the vision; although these things are vital to managing any project. Rather, I propose to restrict myself to the rationalization underlying the use of interactivity in museums. In creating a museum, all individual projects must fit into the overall picture, as parts of the puzzle. When faced by fascinating and seductive technologies such as those lying behind hypermedia, there is the temptation to climb the mountain just "because it's there". Before embarking on the climb, an institution should know what it expects to achieve, and how the venture contributes to its raison d'tre.

There is still a tremendous division of opinion within the museum world concerning a common mission. Without trying to fit the many different types of museum into one mould, it would be helpful - for purposes of forging a true community based on mutual support - to bridge some of the gulfs. There is distrust, amongst traditionalists, of any significant use of media other than original artifacts or specimens to communicate information about heritage; the traditionalist museum provides an largely passive experience to its visitors. Although audiovisual technologies are today quite common in museums, computers are only beginning to shake the image of being new-fangled. When I first came to CMC, in 1982, almost none of the staff had any computer literacy, and a MICOM word processor was high tech; today the roughly 300 personal computers and 5 multi-user host machines are not enough to satisfy staff demands. And we still have further to go in this revolution: we are only on the threshold of true networking in the museum, and still our Informatics and Audiovisual departments are separate - a discrepancy becoming increasingly problematical.

There is a growing appreciation that museums are not about objects, they are for people. Because they bring together many disciplines, many functions, it is difficult to summarize the role of museums. They are more than just collections, or research institutes, or centres of education. Museologists often employ metaphors to communicate the essence of a museum. One that has been used is "the museum as medium"; however, when describing the type of museum we are in process of creating at CMC, I prefer a metaphor comparing museums and hypermedia [MacDonald and Alsford 1988, 1990(b)]. That comparison is what I would like to pursue here, for the light it throws both on the character of museums and on the applicability of hypermedia as a museum tool.

To begin with, I suggest that museums need to think of information, rather than of material objects, as their basic resource. This does not diminish the importance of objects, as a source of information (and museums' medium of specialization); yet it justifies the use of a wide range of media for preservation and communication of the memories of the past. It is important to remember than human culture cannot be fully represented through material objects alone; this in itself necessitates that museums be centres of multimedia (if I may be forgiven for using that term loosely), although there are inevitable limitations on museums' ability to portray culture holistically. Information does not exist in our environment in discrete, independent elements, but in the form of an intricately interwoven structure - an information complex [Malik and Thwaites 1988, 2]. Any experience of part of that environment is liable to supply information of various types: intellectual, sensory, aesthetic, emotional, and spiritual. It is within the nature of the act of understanding to dissect and classify; the way our brains process information favours this. Words and images are tools that the mind uses to isolate and parcel concepts, or elements of experience, which are converted into consensually understood symbols and used to model the world in communicating with others. The two types of symbol are processed quite differently in the brain, and are not really interchangeable - as has been found in a number of projects to create visual databases [Keefe 1990, 670; Lunin 1990, 711; Seloff 1990, 686, 693; Besser 1990, 786]. Whatever the type of input, the brain will modify information patterns received, discarding all but the key features, to create perceptual stereotypes, which can then serve as templates against which to compare new information patterns. This is not to deny that the incredible storage capacity and processing power of the brain allows it much flexibility in establishing links between templates to allow it to address new situations.

Although we hear much of visual literacy versus textual literacy, it is not a question of words or images being superior. They provide different and therefore complementary routes to knowledge. Despite the tendency to compartmentalize information, the ultimate aim is to understand everything as a functional whole: to reconstruct and recontextualize. This is reflected in what has been called the "wisdom continuum" [Traub 1990, 7], distinguishing between data (raw elements of information with no independent meaning), information (data organized within a structure of meaning), knowledge (integration, through purposeful relationships, of informational entities that can be applied to understanding experiences), and wisdom (procedural knowledge enriched with experience).

This categorization parallels another, which differentiates between stages of the learning process [Spiro 1988, 375-77]. The nature of introductory learning is to focus on information; that is, on providing a general orientation to a field, by communicating key information elements for memorization. By compartmentalizing information, a well-structured knowledge domain is created that facilitates memorization, but (by emphasizing only the commonalities between cases) results in oversimplification and creates models that do not correspond to any specific real situation. Advanced learning, on the other hand, emphasizes the context-dependency of information and requires the ability to apply complex and interrelated concepts to individual cases; learners come to appreciate the unique circumstances of each situation and develop the cognitive flexibility that permits customized responses. Finally, expert learning occurs through extensive experience of different cases, and leads to wisdom.

The development both of museums and of hypermedia has in the past been driven largely by their technologies - if, by technology, we refer to computer hardware in the case of hypermedia, and collections management in the case of museums. A growing preoccupation with user needs, however, should mean that both will be more driven, in future, by educational theory. Interactivity, in the sense of active user participation in the learning process, must be an integral part of this. Certainly it is well enough known that participation can be one of the most effective learning strategies. Although hypermedia is an information management tool, in that it is a new way of structuring information of diverse kinds, its main advantage over conventional databases is in the way it allows users to access information and to learn about a subject. That is, as an interpretive tool.

If museums and hypermedia are both information systems whose task is to help users learn about one or more knowledge domains, exploration of the metaphor in the title of this paper may give a richer understanding of the nature of each. I would like to suggest shared characteristics, using my own museum as an example.

Firstly, both are information-intensive environments, embodying resources much vaster than any user can experience in a single exposure. In both cases, however, there is far more raw data in existence than has yet been captured in public access systems, so we are seeing what I would consider stop-gap solutions such as laser disc based inventories in which images have to be accessed through unsophisticated, hierarchical menus.

Whereas most media address individual sensory modes, hypermedia and museums each have the means to increase the number of senses targeted with information. This is not always an advantage, as it can increase the risk of information overload. But the brain is generally accustomed to processing multimedia information, and the variety accommodates different learning styles (e.g. the growing preference for visual over textual information) as well as provides the mental stimulation which holds attention. Visitors seek diverse experiences from museums: they may come to explore, to reverence, to be mystified, to be demystified, to enjoy, to be inspired, and so on. There is no single "right" information delivery system. Some needs can be met by systems in which visitors control the pace of delivery and have time to reflect on their experience - for instance, reading a text, or viewing a static exhibit. Other needs can be met by programmed delivery, in which the pace is pre-determined - such as the case of interpretive theatre or audiovisual presentations. Museums and hypermedia programs can benefit from including both types of information delivery, in ways that deliberately provide changes of pace. Interactivity does not need to be present every step of the way; for introductory learners, passive receipt of information would be the normal mode.

Information delivery is conspicuously at the mercy of technological limitations, both in terms of storage capacity and transmission speed. This is especially true in a networking situation. Rather than devote a good deal of time and resources to creating stand-along multimedia systems, at CMC our strategy is to first establish the infrastructure for information delivery: an intelligent, wide-bandwidth network that we hope will serve us well for many decades. Construction of a new home for the museum, in the '80s, gave us the opportunity to design in conduit and install cabling at the beginning, rather than face hefty retrofitting costs later. The whole building is wired with coaxial, twisted- pair, and (most importantly) fibre-optic cable, in a star topology. Over 1200 outlets, distributed throughout the museum, are linked by this cabling to high- speed switching equipment in the Infocomm Centre, which also houses file servers, laser disc players, computer-controlled VCRs, and a CATV system. One or two small Ethernet LANs are already operating, but we hope to have the whole network operational by the end of this year and are currently looking at multimedia workstations to see which best meets staff needs for a working environment based on interpersonal computing. We expect the network to allow us not only to link together individual databases, but also to provide easy reconfigurability that will let us take information from any source and send it to any destination, as well as combine different types of information.

Layering of information is another characteristic of both museums and hypermedia; it helps guard against information overload. Where an institution's audience is the general public, it is important to design information systems to meet the needs of introductory and advanced learners. It has been suggested, with some reason, that hypermedia is more suitable for advanced learners than novices, because it reveals the complex interconnectedness of information, and requires judgemental skills to navigate through the information in a meaningful way [Huston 1990, 338]. But simpler interactive programs, designed for well-structured knowledge domains, can serve novices. In the museum context, however, the novice corresponds to the casual visitor interested only in browsing the main exhibits for a relatively brief period of time. This audience needs an orientation to main themes of a subject-area, through exhibits that communicate to several senses at once; a sequential and relatively highly programmed experience is not unsuitable for this type of visitor, and will have its greatest impact at the affective, rather than the cognitive, level. For visitors with more time to spend, more intent on cognitive learning, or paying a return visit, there must be another layer of information into which to delve. More specialized exhibits branching off the main circulation routes will serve them; so too will audiovisual and live presentations, participative opportunities, simple interactive computer programs, and audioguides geared to providing information in varying degrees of detail. The third layer of information is for advanced learners (such as scholars) and can be provided at workstations in the galleries or in study areas such as the museum library.

In the case of hypermedia, layering of information is the consequence of branching. There is an implicit structuring here - of main themes and related or peripheral topics - not purely hierarchical, since the movement may be lateral as much as vertical, but more akin to cluster classification. We have tried to embody the same concept in some of CMC's exhibitions. The core exhibits in our History Hall are environmental reconstructions, such as streetscapes. Inside some of the houses, stairways lead to an upper floor where exhibits expand upon aspects of the main exhibits. For instance, above period rooms are non- contextualized displays of domestic furniture; and an area on the main circulation route representing the timber trade through loggers' shanty and sawmill is complemented by an exhibit of tools on the upper floor, a room within the sawmill containing exhibits on the life of loggers' wives, and an audiovisual presentation area showing the history of logging in a particular part of Canada. Similarly, we have explored the possibility of using window-wells - visual links between the History Hall and the First Peoples Hall below - to create cultural cross-references, such as an exhibit in the former representing European immigration into Ontario in the late 1700s, with views down onto an exhibit in the latter hall showing an Iroquois longhouse from the same region and period.

The ideal of hypermedia - associative access, in which every item of information can lead to practically every other, to respond to the idiosyncratic conceptual linkages made by each individual mind - takes it beyond the capabilities of a three-dimensional, real space like the museum. While the tendency of many visitors to roam through exhibitions as their fancy, or interest, takes them is well known, an architectural structure with solid walls, ceilings, and floors places practical limitations on the extent of spatial cross-referencing. But hypermedia systems too have not yet achieved their ideal of free-form linkages of information items. Although museums need to unchain themselves from the pre- determined and rigid-thought interpretations that hierarchical classifications are, they must be wary in trying to implement associative access; for to suggest to users that all linkages are equally significant is to abrogate the responsibility to interpret. We need to devise some kind of weighting system that allows users to follow the routes that best match their interests, yet points out which are the most meaningful, most enlightening, to pursue [Bearman 1989, 318]. The question of meaningful navigation is doubly difficult in the case of an image-base, because of the high level of subjectivity involved in describing the content of images.

Nonetheless, the information retrieval method of associative access - contextualization of a sort, and often compared to landscape navigation [e.g. Jones 1990, 30] - has its attractions, in terms of the possibility of approaching a subject from a variety of perspectives. In its movement away from stereotyping towards a fuller appreciation of reality we see the transition from introductory to advanced learning. The potential here is particularly important in a multicultural society, such as Canada is becoming, where the ability to perceive and appreciate alternative cultural viewpoints must be the basis for social cohesion. It is part of my museum's mission to foster intercultural understanding, by presenting differing perspectives; one way of doing this is to bring persons from different cultural backgrounds into communication (a low- tech form of interactivity).

The analogy of associative access with exploring a landscape leads me to believe that hypermedia is yet at a primitive stage, and its future lies in virtual reality systems. Discovery-based learning will operate at a higher level in virtual space (once the technology matches the vision); virtual reality technologies will broaden the scope of experiential learning through, for example, surrogate travel or roleplaying, as prototype projects are already making clear. Again, the concepts of simulated environments and surrogate experiences find their equivalents in a growing number of museums, including my own, where it is believed that roleplaying is a potent way of helping people learn about other cultures; this is a type of interactivity (with a simulated environment) that we employ particularly with younger visitors, who are more partial to an enactive mode of learning. But even the apparently passive experience of watching interpretive theatre can provide for some intellectual and emotional participation on the part of audiences. Simulation will not in the foreseeable future have the full impact of reality - even the holodeck of Star Trek has its limitations - but the reality of our past has disappeared, and most of our knowledge of the past derives from simulations under the more respected title of "hypotheses".

The potential for creating extremely rich information environments and sophisticated methods of navigating through those environments is expected to empower users, by encouraging decision-making and exploration of a subject from different viewpoints, and thereby nurturing critical faculties. Although not new, this notion is only now beginning to take root in the museum world [Stapp 1990, 5]. My museum shares this goal, and its inherent distinction between learning and teaching. The purpose of CMC's interpretive theatre programme, for instance, is not so much to convey information as to provoke audiences to begin thinking about the dramatized issues, which they are encouraged to discuss with interpreters after each performance. However, I have yet to see any documented evidence that this empowerment is actually happening; it would be comforting were some confirmation available. One of the problems shared by museums and hypermedia programs (at least, those made accessible in public places) is that most users' attention is not held for long enough periods to take good advantage of an information-rich environment; information is merely skimmed, rather than explored in depth. This too supports the need for layering information, and for the belief that hypermedia best serves those few visitors who are interested in penetrating into the deepest layers. From my own observations at my museum, I conclude that interactive computer systems in the galleries receive only short duration sampling (and are therefore most useful when programs are structured so that discrete units of information can be retrieved quickly), whereas those in our library are used for longer study sessions. Although many of CMC's information resources are still in analogue formats - and there remain strong reasons for preferring analogue to digital in some contexts [Bearman 1989, passim] we are looking ultimately towards digitization, partly because of the contribution it can make to an empowering environment by allowing users greater ability to manipulate information. Better integration of media also argues in favour of digitization.

The point has often been made that interactive computer systems - particularly complex databases such as hypermedia and virtual realities - are at this time seriously deficient as regards user interfaces, a deficiency impeding ease of interactivity. This is an especially relevant concern in a museum, where the audience is a diverse one and will contain many who are not computer literate. More naturalistic input methods are needed, and in this area hypermedia development can learn from museums. Although the sense of touch (the source of our more specialized senses) is the most difficult for computers to deal with, machine recognition of pointing - whether by hand or by sight - is now technologically feasible; a primitive version of pointing is already catered to by touch-screens, which are the standard for public interfaces to interactive computer systems at CMC. Voice communication is also on a near technological horizon. Museum visitors are well accustomed to using both methods as part of information retrieval in exhibitions. The issue of interfaces again illustrates the importance for interactive systems to be driven by user needs rather than by technological tradition. At the same time, neither museums nor hypermedia developers can afford to ignore that the expectations of users are pre- conditioned - that is, they have perceptual biases and technological preferences - by the commercial marketplace, which is driven by the entertainment industry. Again, for this reason, I am inclined to think an arguably premature transition to digital media (notably CD and its variants) inevitable.

Digital media are also favoured by the transmission factor. While there are plenty of stand-alone systems now in existence and some localised multimedia networks, much rarer but badly needed are wide-area networks and multimedia information utilities. No individual museum encompasses all knowledge; the same is true of individual hypermedia systems. To achieve the fullest potential of museums, as information resources, we need to surmount the challenges of technology and standards and move forward both in pooling resources, through telecommunications connections, and of reaching out to the public beyond museum walls. This too is why at CMC we have focused our attentions on creating the infrastructure of a network (along with television studios) capable of serving both internal and outreach needs.

I have seen some excellent low-tech museums. Today's new interactive technologies are not essential to museums, but at CMC we believe they can better help us serve our audiences and meet the goals we believe important to a institution with a responsibility as an information-provider. Both interactivity and new technology are trendy today, and it is important to resist them becoming ends in their own right. At the end of the day they are only tools to help museums achieve educational goals. But I believe that, as the high comparability of museums and hypermedia suggests, they are relevant tools, compatible with the purpose of museums.

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Virtual Museums and Virtual Realities

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The notion of *virtual museum* is discussed and related to various developments in user-interface, software, and communications technology. A prototype implementation, intended to explore the integration of interactive 3d graphics with video imagery is described.

1. Introduction

The traditional museum is a setting which allows people to visit and admire artifacts in pleasant surroundings. However there are many characteristics of this view which constrain the operation of museums. We will examine some of these characteristics and discuss their resulting disadvantages.

First, the artifacts on display are supposed to be *real*. For example, a real amphora is displayed and not its photograph or some other facsimile. There are many disadvantages to this practice: Some artifacts are too large, or may be incomplete, making their display difficult; expensive measures have to be taken to assure security for the artifacts; and the displays need environmental conditions which preserve the artifacts and make it comfortable for people to view them.

Second, the setting for displaying the artifacts is *real*. That is, a building is specifically used for their display. Such a setting is very expensive both in its construction and its operation. As the number of artifacts increase, both new and old, museums have difficulty providing their archival and storage, let alone their display. As a result, a great number of artifacts have little possibility of ever being displayed.

Third, people have to come within direct *proximity* of the artifacts. This implies that people have to travel to reach the museum and then circulate inside to see the artifacts. While this encourages tourism, in general it is debatable whether it is the best approach. The people rarely see the artifacts where they were found, but instead where they can be concentrated for historical or financial reasons: artifacts end up being displayed where people are rather than in their natural environment. In addition, moving artifacts is dangerous and expensive.

Fourth, artifacts are usually *passive*. People can see them but they can not "play" with them. For older generations this is fine since they have been accustomed to see but not touch. For younger generations it is not sufficiently exciting. They want to directly explore different possibilities and see the results, but we cannot, of course, let children play with real amphoras, break them, and reconstitute them.

In the end one wonders what is the actual purpose of the museum. It is not simply to display. Instead the goal is to create an *impression* on people and to make them *imagine*. The question remains whether displaying real artifacts in real settings for people to pass by and passively look at is the only or the best way to achieve such goal. Many changes already present in museums point to the contrary.

2. Easing the Constraints

The first constraint of *real artifacts* is not strictly adhered to. Photographs, slides and books have been used for sometime to create the impressions usually reserved for museum trips. More recently a similar role is being played by film documentaries and videos. Extrapolating this trend leads to multimedia representations of artifacts stored in a database accessible through computer programs. Museums have therefore to deal not only with their artifacts but with all the multimedia representations of artifacts (whether theirs or others) which are relevant to their theme.

It is becoming possible to also relax the second constraint, that of a *real setting*. We can show multimedia representations of artifacts (let's call them virtual, as opposed to real, artifacts) in real settings *or* virtual settings. A virtual setting is a computer model of a setting. The model may be based on a real setting or it may be completely imaginary.

The third constraint of people's *proximity* to the artifacts can also be relaxed. Documentaries have accustomed people to taking tours in museums without going there. Simulated tours are even better. They give the impression of actively participating in the tour rather than seeing a canned presentation. Live video and the possibility of diffusing through high bandwidth networks can make such tours even more exciting since it can enhance this sense of participation.

Finally, science museums have for some time accepted the idea of *active* as opposed to *passive* displays. Designing active displays is often expensive and time consuming when we deal with real artifacts. With virtual artifacts in virtual settings the possibilities are enormous. Each artifact can be represented by a software construct which can be manipulated in many ways.

What we propose is to ease all the constraints at once. In this way, a museum will deal with virtual artifacts, in a virtual setting accessible from a telecommunication network in a participatory manner. Such a museum is a service not a location. It may not exist at all, other than as bits of data. That's why we call it a *virtual museum*. In the next sections we will discuss the available technologies which can make such virtual museums realistic (sic!)

3. Technologies

Recent technological developments, and the maturation of earlier technologies, is furnishing the needed context to construct virtual museums. These technologies (see [9] for a highly readable description of many of the following) include:

1. high-bandwidth networks
   Current commercially available local area networks typically have a bandwidth between 1 and 10 M bits/second. Research prototypes have achieved considerably higher data rates, and networks in the gigabit range may soon be widely accessible [7]. Combined with new data compression techniques, such networks will support a large number of digital video and high-quality digital audio channels. This allows one to construct, for example, video servers, i.e., video repositories that can be reached by network connection and that can send video information over the network in real-time.

2. multimedia workstations
   The continuing progress in HDTV (high definition television), CD-I (Compact Disk - Interactive) and DVI (Digital Video Interactive) is spurring the development of multimedia workstations [8]. These machines allow applications to manipulate and present multimedia information (including audio, video, graphics, high-resolution images, and text).

3. hypertext / hypermedia
   The extension of hypertext techniques (the linking together and cross-referencing of text segments) to multimedia information has led to hypermedia. If multimedia information is stored in a hypermedia web one can, for example, navigate from a video about a particular topic, to a textual description of the topic, to an audio recording etc.

4. interactive 3d graphics
   High-end graphics workstations have now reached the point where it is possible to generate complex scenes at rates suitable for real-time interaction. For example, one manufacturer quotes 100,000 shaded polygons per second [1]. At 10 frames per second (about the minimum needed for real-time interaction) this allows scenes of about 10,000 polygons.

   When the display from such workstations is connected to an EyePhone (a head-mounted display device which also provides the computer with head position and orientation data) one can surround the user with *virtual reality*[10]; i.e., synthesized 3d imagery which changes in response to changes in the user's orientation (and position). Finally, an input device called the DataGlove, allows the user to reach about and interact with objects located within this synthesized world [2].

5. groupware
   Groupware refers to systems which support multiple users engaged in a common task within a shared environment [4]. *Desktop conferencing* is one example of groupware, it allows users to establish audio and perhaps video connections from their workstations

and jointly operate a computer application such as a document editor [6]. Another example is the multi-user virtual reality system RB2 (Reality Built for Two) [2]. The definitive characteristic of groupware is that it provides each user with notification, or feedback, of what the other users are doing. In a sense groupware acts as a medium for group interaction.

6. active objects
   Active objects [3] are programming constructs that possess a high degree of autonomy and local control. They are well suited for complex simulations involving many parallel activities. In particular, active objects can be used to model *reactive* environments; environments which respond to the presence of one or more users.

4. Realizing The Virtual Museum

Given the above list of available technologies, the following scenario suggests itself:

- A 3-dimensional model of a (real or imaginary) museum setting would be produced using various modelling tools such as CAD packages. This model would contain layout (i.e., floorplan) information, visualization information (the color of the walls etc.), and an indication of the position of artifacts.
- With current technology, most artifacts would be too complex to handle as 3d objects (plus such data would be very time consuming to acquire), instead artifacts would be represented by high resolution images and video clips.
- Descriptions of artifacts, whether textual, graphic or audio, would be linked to the artifacts themselves as part of a hypermedia web.
- All the above data (museum model, artifacts, descriptions) would be available via network connection from a "museum server."
- Clients of the server run a virtual reality user-interface. When the client first connects to the server, the museum model is downloaded. As the user moves through the museum the server is kept informed of the location of the user.
- A museum server may allow multiple clients, i.e., groups may enter the museum. In this case the server coordinates and broadcasts group state information (such as the locations of all members of the group).
- Users may "activate" artifacts (for example, by pointing at them). This would result in a window appearing in their virtual world. Within the window the artifact's video or image data would be displayed. The user could interact with the window and activate any of the descriptive information associated with the artifact.
- Active objects would be used by the server to handle interactions such as the above. For example, if an artifact is activated by a client then its corresponding active object starts sending artifact information to the client (or clients).

- Active objects would also be used to handle more complex processes within the museum. For example the museum could respond to large groups by growing its rooms (i.e., increasing their size). This would require an active room object which monitors its number of inhabitants. Another example is a museum guide, an active object which follows a particular path through the museum and the hypermedia web (and "drags" along a group of users).

A system as described above could be built using current technology. Steps along these lines have already been taken. There are a number of virtual reality prototypes and products; also some museums have started to make the artifacts available in digital form. (For instance, the Smithsonian has produced a CD-I application [8] and the Gifu Art Museum in Japan has an HDTV system for viewing its collection [5].) What is perhaps unique about the above proposal is that it integrates a number of technologies which have yet to be found together in a single application.

5. A Prototype Virtual Museum

One aspect of the previous proposal is the integration of 3d graphics with video material. Despite advances in 3d graphics hardware, virtual realities tend to be rather simple and cartoon-like in appearance; so we believe video imagery is needed to make virtual realities more compelling visually.

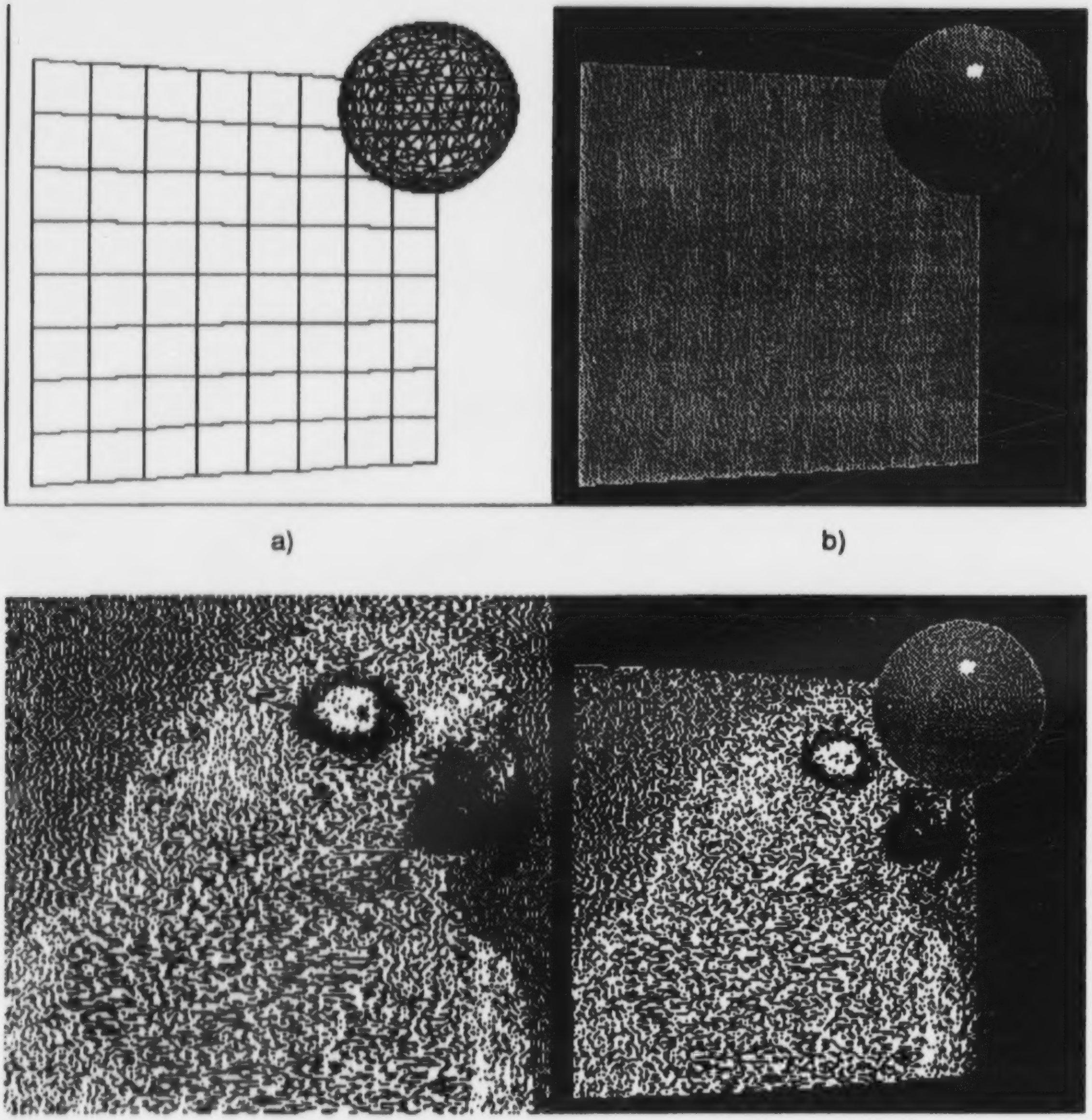
The problem can be stated as follows: 3d imagery is generated so that it responds to changes in the user's visual perspective. A video source, such as a VCR or laser disc, provides a video signal which is overlaid on a "video surface" appearing in the 3d imagery. For simplicity we assume that the video surface is rectangular (in world coordinates) and of the same aspect ratio as the video signal. However, because the user may not be directly in front of the surface, the surface may appear skewed. Also the surface may be fully or partially hidden by other objects. Thus the video signal must be transformed, and possibly clipped, in order to correctly fit on the video surface. The steps in this procedure are shown in Figure 1.

At the University of Geneva we are interested in exploring video and 3d graphics integration and applying our earlier experiences with multimedia, active objects and groupware. In order to experiment with video / 3d graphics integration we wanted an application domain with a rich supply of visual material. This led to our interest in the virtual museum.

Presently we are designing a prototype virtual museum which is depicted in Figure 2. Hardware components are represented by rectangles, processes by circles (which may be implemented in hardware, open circle, or software, shaded circle), arrows represent inter-component data flow.

The processes include:

- u – user input. The GeometryBall is a joystick-like device with 6 degrees of freedom (3 translational and 3 rotational). This allows the user to navigate in 3 dimensional space.



a) b)

c) d)

Figure 1 Part of a 3d model is shown before (a) and after (b) rendering. The model consists of a rectangular grid, which appears skewed because of perspective, and an occluding sphere. A frame from a video signal (c) is mapped onto the rectangular "video surface" (d).

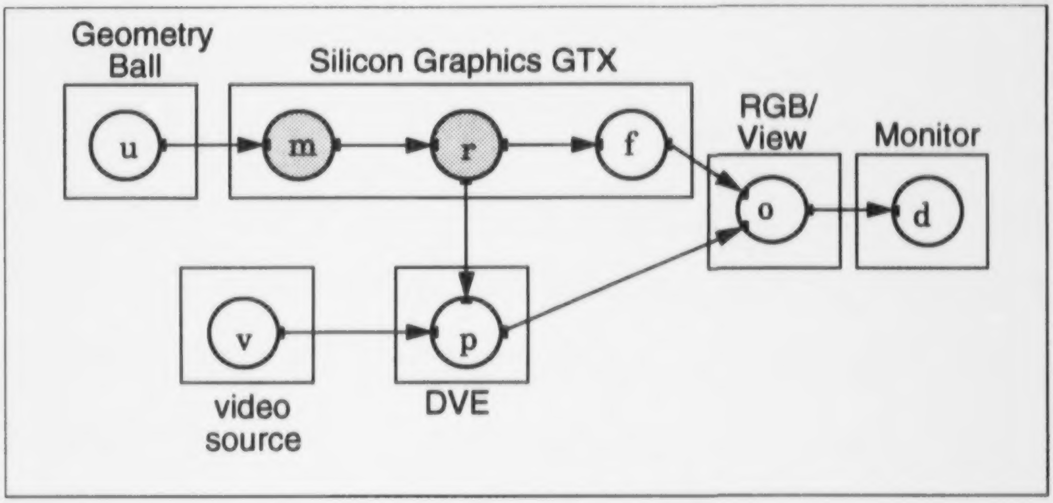


Figure 2 System Components

- m – model. The model includes the surface geometry of the virtual museum, shading attributes, light sources, video surfaces, and the user's current position and orientation (which is updated as values are received from the GeometryBall).
- r – renderer. The renderer shades the 3d model and writes a digital representation of the current view in the framebuffer. It also determines the perspective transformation needed by any visible and active video surfaces and passes this to the DVE. The model and renderer are implemented on a graphics workstation.
- f – framebuffer. This high-resolution (1280 x 1024 x 24) framebuffer produces a RGB signal.
- v – video source. A standard computer-controllable video source such as a laser disc. It produces a low-resolution composite video signal (NTSC).
- p – perspective transformation. The DVE ("digital video effects") unit applies a perspective transformation to the incoming video signal, producing a new video signal.
- o – video overlay. The RGB/View merges the high resolution RGB signal coming from the framebuffer with the composite video signal. Its output is high resolution RGB.
- d – display. The merged RGB signal is displayed on a 19" color monitor.

As described above, the prototype perhaps would not be termed a virtual reality since the display is not stereoscopic. However, this is primarily a matter of expense; essentially duplicating the hardware (creating one "channel" for each eye) and replacing the monitors with a head-mounted stereo display is all that is needed to obtain a virtual reality interface.

6. Concluding Remarks

The advantages of a virtual museum are many. First, it offers economic access to the artifacts to many persons and to those, such as the physically disabled, for whom it might not be possible otherwise. Second, it is safe for the artifacts. Third, it allows each artifact to be displayed. Fourth, the setting can be approximately chosen or even specially composed. Fifth, people can combine, operate on and generally "play" with the artifacts. Finally, it can show to people scenes which otherwise could only be imagined.

It is also worthwhile to ponder the disadvantages. First, real artifacts should be more impressive than their audiovisual representation. Unfortunately, for security reasons, real artifacts are becoming increasingly remote and so appearing less real. Second, real settings should be more exciting. Most settings, however, are simulated and not exactly "real." Display of virtual Egyptian artifacts in a virtual Egyptian setting may be more realistic than the display of real artifacts in a showroom in Paris or London.

Third, visiting a real museum is often exciting because of other people being there. Nothing prevents, however, virtual museums from being experienced by a group. A class or family could collectively explore a virtual museum and interact with other visitors. Finally, active participation is optional and not destructive. A person wishing a passive view can leave operations to a virtual tour guide.

The question remains of who should get involved in providing such services. The entertainment industry and technology companies will surely get involved; they have the technological knowhow and financial strength. Museums, however, have the raw data and should not just give them away. They should be active participants in such an operation – not only to obtain extra funds and retain their clientele, but mostly to assure proper historical and scientific control of what is displayed. People should see not what entertainers would like them to see (intellectual sugar), not what the computer people can make them see (surface quality), but what artists and historians and archeologists would like them to imagine.

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Multimedia Design Research
for the Museum Education Consortium's Museum Visitor's Prototype

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Abstract

The design and development of interactive multimedia applications is a complex and challenging process which is still evolving as the hardware, software, creative talent, production services, publishers, and target markets all evolve at the same time. Compared with other media, such as print, film, radio, or TV, interactive multimedia, as a medium that combines many media and makes use of them interactively, is still relatively new, at best fifteen years old. The design and development process is far from standardized, although effective design formats and templates have begun to emerge in certain sectors, such as for corporate and military training materials and for children's videogames. Technical advances continue at such a rapid rate that even experienced designers have been kept on a steep learning curve for over a decade. Many design issues of how best to use interactive multimedia, why, when, for whom, and where are still being explored. The project described in this paper is an example of a research and development effort that has attempted to address some of these questions in the context of museum education.

From 1988 to 1991 the Museum Education Consortium, comprised of the Directors of Education of seven major art museums, contracted a team of consultants, coordinated through the Museum of Modern Art in New York City, to design and produce an interactive multimedia prototype for museum visitors. The design research effort involved the acquisition of a database of images of paintings and documentary text, film, sound, and motion video materials, the creation of a discovery-based interactive prototype for musuem visitors, experimentation with high resolution digital imaging and high definition television filming, and formative testing with museum visitors using the interactive prototype, which provided invaluable feedback about the effectiveness and appeal of the interactive design.

The Museum Education Consortium

The Museum Education Consortium is a collaborative effort among the education departments of seven art museums: The Art Institute of Chicago, the Museum of Fine Arts, Boston, The Brooklyn Museum, the Metropolitan Museum of Art, The Museum of Modern Art, The National Gallery of Art, and the Philadelphia Museum of Art. It was founded in 1987 to investigate the roles that technology might play in museum and art education in efforts to provide more effective access to the arts. Several research and development prototypes have been developed over the past five years as part of this research and development effort. This paper briefly describes the design and development of one of these prototypes, called "The Museum Visitor's Prototype" (1988-1991), which was created as part of the larger research effort to explore new methods for introducing visitors with little or no background in art or art history to different ways of looking at and thinking about paintings. The work of the consortium has been funded by The Pew Charitable Trusts, the J. Paul Getty Trust Grant Program, and the Andy Warhol Foundation for the Visual Arts.

The Museum Visitor's Prototype

The Museum Visitor's Prototype is an interactive multimedia prototype that was developed as a discovery-based learning experience for testing with adult museum visitors, who have limited knowledge of art history or art. It was designed to be used in an art museum setting by one person alone or by small groups of visitors for five to fifteen minutes. The goals of the prototype were several:

1. To introduce users to new tools for learning to look at and reflect on works of art using the features of interactive video technology to facilitate this process and to enjoy the experience of looking at art,

2. To pique curiosity and foster self-directed exploration in an engaging way so that the experience of using the interactive prototype would be enjoyable as well as informative and would be based on each user's individual interests and evolving knowledge base,

3. To offer easy access to a rich multimedia information base of images, films, and text so that users would come away with an increased understanding of selected Impressionist and Post-Impressionist artists and their work.

Although the final product will most likely explore several artists, their work, and their life and times, the prototype focuses, for the sake of example, on one artist and, in fact, on one painting: Claude Monet and his "Waterlilies" painting (1926), which is currently at the Museum of Modern Art in NewYork. The discovery-based design of the prototype allows for access to information about a variety of paintings, sketches, details, artists, and documentary images and films, particularly as they relate to Monet and his work. The three frameworks for exploration in the prototype include:

- 1. **Paintings** - looking at the painting, "Waterlilies," itself,
- 2. **Artists** - finding out about the artist, Claude Monet, through his studio,
- 3. **Context** - finding out about relevant historical contexts, such as Monet's life in his garden at Giverny, that reveal something about the life and times of the artist.

A video overview introduces the prototype's contents and how to use its interactive features. Audio commentary, often accompanied by "talking heads" video, is available from several different characters, including a museum educator, a museum visitor, a cultural historian, and an art student. Various interactive features include visual zooms to details of paintings, a timeline of cross-referenced historical and contextual information, open-ended questions for directed looking, and side-by-side comparisons of paintings or between paintings and film clips depicting the location painted. Access to information is made available via selectable, "hot," sections of visual menus, such as canvasses and journals depicted graphically in an image of Monet's studio, and through the selection of pictographic icons at the top and bottom of the screen.

Since the project was a research and development effort, the consortium decided to experiment with the creation of a design research prototype that included a potpourri of design ideas and features which could be tested with visitors for their effectiveness. As such, the prototype is somewhat unusual in that it attempts to explore the possiblities of a discovery-based design for adults and has a variety of features and options for testing, rather than a single, consistent interactive blue print for a final product. The prototype runs on a hardware platform that includes a Macintosh II computer with extended memory and Truevision's Nuvista image capture and overlay board, a Pioneer 4200 videodisc player, an Electrohome color monitor, and stereospeakers. In an effort to test reactions to the image qualtity of images stored in different formats, images in the prototype are displayed in both analog form from the videodisc and digital form from the computer's hard disc. Some of the motion footage was filmed in HDTV, as a part of the image quality testing, then down converted and stored on the videodisc. The input device is a mouse.

Key Design and Production Issues

Many people contributed to the various phases of the design and production of the Museum Visitor's Prototype, as with most interactive multimedia projects. The team included people who worked on project management, design treatments and storyboards, content and image research, production, image, film, and sound acquisitions, post-production, digitizing, disc mastering, C programming, graphics, and formative testing. Among the major contributors were Jane Freeman, Mary Lewis, Frankie Mann, Judy Meighan, Alan Newman, Sharon Picker, Nancy Richner, Robin Sand, Dorothy Shamonsky, Susan Stedman, and Kathy Wilson. While the design and production team worked on the evolving interactive prototype, a number of key development issues became recurring themes discussed by the team, as well as by the consortium as a whole. Some of these issues included:

- 1. What is the more appropriate **pedagogical approach** for a particular application? What are our goals? What do we hope users will gain or learn by using a particular application?
- 2. What is the **best use of interactive technologies** in museum settings and in art education in general?
- 3. How do you define the **target audience** of museum visitors? Who is this application for? What is the **target context** for use? Where within a museum setting will interactive technologies best be used? Where outside the museum? Where will a particular application be used?
- 4. What is the **expected interaction time**? How long do we expect users to actually use it?
- 5. What is the content area we are interested in? What kind of **content research** should be done for a multimedia database (photographic images, film clips, sounds, music, text, etc.) and who should do it? What are the key **image acquisitions and rights clearance** issues? How is this research different from traditional scholarly research? How is editorial control determined? Who is the "author"?
- 6. How **relevant** is an interactive application to current museum practice? How does it complement existing materials (for example, wall labels and brochures) and practices (for example, gallery talks and lectures)?
- 7. What is the optimal **user interface design**? What is the nature of the interaction we want to encourage? How will we introduce, contextualize, and facilitate the interactive experience to make it more inviting, accessible, and meaningful?
- 8. What is a **prototype**? What is a "deliverable" for a research and development project? How important are production values in a prototype? How complete and consistent should a prototype be?
- 9. What is the most appropriate **hardware and software** to use? How do you make such technical decisions?
- 10. How can the effectiveness of a prototype best be **evaluated** to meet our goals with our target audience in our target context?
- 11. Can interactive programs be designed that will **encourage seeing the real works of art** in museum galleries?
- 12. Is the **image quality** of existing hardware and imaging systems good enough to display works of art? How can you display the best possible color and clarity?

Highlights of the Formative Research

Over the course of 1990 and 1991, Nancy Richner and I conducted some small scale formative research studies with museum visitors at the Museum of Modern Art in New York and at the Brooklyn Museum using the preliminary Museum Visitor's Prototype, described briefly above. As with most formative research, our goal was to get a better feel for the effectiveness of the prototype with our target audience in our target context. Toward this end, we observed visitors using the prototype to get a sense of which of the design features among the potpourri of design ideas we experimentally included in the prototype seemed to work best. We used this feedback from visitors as a basis for focusing and revising the design of the prototype in an effort to create a more effective product.

In our formative study, we considered some of the classic formative research questions that typically have to do with issues of,

- 1. **Appeal** - Do they like it?
- 2. **Useability** - Can they use it?
- 3. **Relevance and Meaning** - What do they get out of using it? Of what value do they think it is? What kinds of things do they learn from using it? (although this last issue is always difficult to assess with a protoytpe, which by nature is incomplete in terms of content depth and richness).

We also tried to observe more closely how museum visitors deal with and think about the challenges presented by a prototype such as ours, which is unfamiliar to many on at least one, if not all three, of the following fronts:

- 1. In terms of the **technology** it uses,
- 2. In terms of the **discovery-based** navigational design,
- 3. In terms of its **content.**

We met with 45 visitors, mostly in pairs. These were people who came to the museum with someone else: husbands and wives, mothers and daughters, mothers and sons, unmarried couples, female friends, male friends, fellow students, work colleagues, etc. For our formative studies, the prototype was set up in spaces allocated by each museum for educational activities. In both museums this space was somewhat remote from the museum's lobby entrance, cafeteria, gift shop, or galleries. We approached visitors for our studies mostly in the lobby areas. Two researchers met with each pair of visitors for 20 to 30 minute sessions.

The reactions and comments from visitors during and after using the museum visitor's prototype, combined with our observations of their strategies for using it, illuminated a number of interesting, and perhaps general, issues about the great variety among adult museum visitors in terms of things such as their comfort level with using new technologies, their attitudes toward learning something new, and their great variety of styles for approaching and learning to navigate through a discovery-based environment. Although the reactions from visitors led to specific ideas for revising the design of the museum visitors prototype, we will focus here on some of the many issues raised in the course of our observations, which are, perhaps, pertinent in a more general way to the design of discovery-based interactive multimedia environments for adults.

1. There was a Wide Variablity among Museum Visitors

The variability among museum visitors to these two museums was amazing: in terms of their age range (ages 14 to 77 in our sample), their familiarity with art or art history, their prior use of computers, and more specifically their use of the mouse and Macintosh interface, their geographical distribution (MoMA, for example has many international visitors), their time commitment to their museum visit, their inclination to try new and different things, their relationship to the person with whom they're visiting the museum, etc.

2. Different Strategies of Use

In keeping with this variability was the fact that everyone approached and used the prototype in a unique way. Some people jumped right in, trying all the options, scanning the prototype's depth and breadth. Others proceeded cautiously, asking questions at first about how to proceed, where to go, and what to do. Some plodded very methodically through the options, in a linear way, top to bottom, left to right. Some used the character, Amelia, as a guide. Some enjoyed reading the text, often aloud. Some viewed the films, others stepped through images of collections of paintings. There were sometimes great differences in strategies for using the protoytpe between people in the pairs.

3. Hands versus Mouths

One pattern that was true in many cases, as with anything new, was an initial period of "getting to know" the prototype, of finding out what it was, becoming at ease with it's initial newness, and "figuring out" how the discovery-based navigational design worked. It was primarily during this initial encounter with the prototype that we found some people questioning with their mouths what they were actively doing with their hands. For example, some people would be in the process of selecting an option, when they would ask the researchers if they could select the option. Their hands seemed to know how to do and be willing to do what their mouths expressed hesitation or doubt about doing. Part of them seemed to be having fun exploring and discovering, while the other part seemed to question this, to want clarity and reassurance that this was o.k. Some comments included:

> "Some people might be hesitant with the mouse, not sure what's there, but you play with it and you find out."
>
> "It branches out a lot. There is no single route through it, no preset destination. I didn't know where I was. I was wandering. I felt I wanted to spend more time, to stay with it, to figure it out."

4. It's Engaging

Most people, when we first enlisted them as volunteers in the lobby, made it clear that they didn't have much time to spend with us, since they didn't have much time to spend in the museum as a whole. However, in almost every case, despite initial hesitations, people became so involved and engaged with the prototype that we had to interrupt them to remind them that 20, or more, minutes had passed, which was longer in most cases than the 10 or 15 minutes they had felt they could spare originally.

5. What is this Thing?

Many of the visitors found the experience of using the prototype so new that they seemed to be working through with themselves and with each other issues, such as "What is this thing? What is it good for? Who is it for? and Where should it be used? In museums? homes? schools?" They had typically come to the museum expecting to see paintings, perhaps to read wall labels or pamplets or to hear a docent, but none had come expecting to use this experimental interactive multimedia prototype. It didn't fit into any of their preconceived notions of a museum visit, and they often remarked on this, pondering its nature, its role, and its place, with each other. In addition, for many of those who had used computers before, their experience with the prototype didn't fit into their prior experience of using computers. As one visitor said:

> "This is really interesting and fun. Anyone with half a brain could figure it out. I think it's great. I don't like computers but this I like. You get a lot more detail here. Even a docent couldn't give you this information. If you're not interested in art, this would be great. You see, you say, "oh wow," you get interested. One thing leads to another. You dig deeper.Where would it be? One wouldn't be enough. This would be great in schools."

6. Learning Through a Discovery-Based Experience

Some adults found it very difficult, at least at first, to let themselves go and simply explore the prototype in a discovery-based fashion, at least not without some initial verbal questioning and resistance on their part. Once visitors unfamiliar with the technology became more comfortable with it and the use of the mouse to select icons and "hot" sections of graphical menus, most became quite absorbed with the images and interested to discover the information made available to them in the prototype. Many felt that they learned new things and came to think about paintings and artists differently. Some of their comments were as follows:

> "I learned a lot. I didn't know about his studio, his garden. This is much more than just a painting. You have a chance to sit down and get the context. I like the back and forth between the painting and the context. It's a really neat idea."
>
> "I think it's great, the color, the questions it asked, the information it gives you, it's great! I like the whole concept of it. So often when I read about art I only think about what the book says. This leads you to other questions which stimulate your thinking. "
>
> "It doesn't talk down to you. It's not overwhelming. You can chose what you want. It's very visual, therefore, it's good for people who have no background in this area. It's impossible to sit down and look at things in a museum without something like this. This opens up information. It's easier than a book. It's great to have the context it's visually satisfying."

7. Mediated Conversation

In a great number of cases, the prototype was a stimulus to conversation in interesting ways. It's images and content, as well as it's many design options, seemed to provoke discussion and interaction among the pairs. At times this back and forth discussion was a sort of thinking through together what they wanted to do, and how they wanted to proceed. At other times, it was a vehicle for discussing personal connections to the images and information, such as memories of a visit to Giverny or reactions to a particular painting. Sometimes it was an exclamation of surprise over discovering something new, such as "I didn't realize [Monet] designed the garden at Giverny himself!" As one visitor said, "So many people come to look at paintings, but this makes people think. This makes people think and verbalize."

Summary

Our formative research sessions spent observing visitors using the interactive multimedia Museum Visitor's Prototype in the context of two, quite different, art museums were invaluable in terms of providing useful feedback about the effectiveness of the prototype's various design features to meet its goals with its intended audience. Through this process the concepts of the design and production team as implemented in the preliminary prototype were confirmed or disconfirmed and suggestions for revisions were generated. In general, we found that after spending about 20 minutes exploring the prototype's interactive features and content richness, and overcoming, in some cases, any initial apprehension about it's newness, museum visitors were quite enthusiastic about the prototype, engaged by it, able to give us good suggestions for design revisions, and definitely felt it had importance. Their parting comments included:

> "I like this. It's very good, it's the way things are going. It's nice to see a useful use of computers. I'm glad you're developing this. It's another way to introduce people to paintings look at paintings. You have lots of choices. You try them all. I like the voluntary aspect, I like the options, you can pick what you want. This is patient, responsive, it seems to wait for you. You want to linger, to take your time, leisurely, to see what's there."
>
> "I like it. It's nice. It's easy to get around. It makes me want to see the real paintings now."

Ultimately, this iterative process of design, research with visitors, and re-design will lead to the creation of a more appealing, useable, and effective product for the intended target audience. In the future, based on the results of various research and development efforts such as this, it is possible that better and more diverse interactive multimedia products will be developed to complement the array of educational materials and services currently available in art museums, such as wall labels, slide sets, audio guides, videotapes, brochures, and gallery talks. It is our hope that by attempting to offer a diversity of effective and appealing educational materials to the public, we will better insure that there will be something accessible and appropriate to the unique needs of each visitor, regardless of age, background, learning style, or interest.

Designing the Public Interface

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Abstract

In the age of mega lawsuits over ownership of computer interface metaphors little time is spent on an issue critical to successful interactive museum exhibits - the "public interface". A public interface which is responsive to a general audience is a key to the museum visitor's exploration of interactive exhibits and can foster a positive response to the application of learning technologies in museum environments. In contrast to interface designs for standard operating systems and applications software, the primary focus of a public interface is to: quickly engage the casual visitor, demonstrate the use of the exhibit, and facilitate their informal learning experiences. Based upon experience in the design of interactive science education exhibits, the author identifies and discusses key interface design issues including: navigation and content structures, formative evaluation, appropriate application of media, multi-disciplinary design teams, input controllers, and hardware issues.

Introduction

Museums are frequently viewed as consumers of software and computer technologies. Recently a new trend is emerging - that of the museum as a software developer or development partner. This trend is partially due to the desire of museums to make interactive software-based exhibits which reflect the needs and desires of their particular museum and its audience. Broad public usage of interactive exhibits necessitates new questions in the museum environment:

- how does the visitor interact with these new exhibit forms?
- do they replace other types of exhibits or displays?
- how does a museum go about designing an interactive exhibit?

- how can these exhibits be evaluated?
- who will use them?
- can these exhibits be made in-house ?

The focus of this paper is the design of computer based exhibits which directly engage the museum visitor, and the mechanisms which allow the user easy access to the information - the "public interface". Design principals of interactive exhibits have similar underpinnings despite the various uses museums put them to: as information kiosks, orientation systems, electronic titles, electronic learning centers, etc. Without clear design principals museum politics are liable to replace the design and evaluation process. The design of an interactive exhibit necessitates the integration of numerous skills and points of view (usually dispersed amongst competing departments) and the formation of an interdisciplinary design team.

Interface Mechanics

In order to attract and sustain the public's attention, an interactive exhibit needs to: quickly engage the casual visitor, demonstrate how to use the exhibit, and be a cooperative partner in the visitor's informal learning experience. To facilitate these goals the exhibits need a close integration of the content structures and the interface mechanisms used to explore it. The mechanics of a public interface include:

- visual elements (screen layouts w/ graphic windows)
- sound elements (sound effects, narration, and music)
- screen controllers (on-screen buttons, switches, knobs, etc.)
- mechanical controllers (buttons, knobs, joysticks, mice, trackballs, touch screens)
- text elements (titles, content narrative)

The combination of these elements in a public interface requires the integration of fairly disparate disciplines, and can potentially offer museums new forms of exhibits.

Interface Criteria

A public interface has unique considerations which differentiate it from the better known interfaces used on the Macintosh operating system or Windows on the PC, or other platforms. Public interfaces have a stringent premise - the user only has between ten seconds to a few minutes to figure out how to use the application. Your typical computer interface presumes that the user will spend as much time as necessary to face the "learning curve" for the desired application. Design considerations for the "public interface" used in the museum environment include:

- general lack of computer literacy
- limited interaction time
- tailoring for multiple age levels

- varied reading skills
- subject matter complexity
- consistency of user interface across multiple applications
- information overload
- sonic and visual environment surrounding exhibit

The primary criteria for developing the public interface is defining who is the public. Museums generally attract a wide and diverse audience of varying ages, backgrounds and interests. Defining the age group, cultural background, reading skills, interests, size, and single/ multiple users will help define who is the intended audience and any specific considerations related to that audience.

A second criteria is determining how long an interaction is desired. Most hands-on mechanical exhibits average less than one minute of involvement. The interactive exhibit can have the potential for short involvement by design or extended involvement (up to 1/2 hr. or more) depending on the scope of the content. Other factors affecting interaction time include:

- single or multiple use
- school group vs. family group
- location on museum floor
- age of user
- comfort / visibility

Given the breadth of the visitors' interests and experiences, a third criteria is deciding what sensory learning modes shall be addressed: reading, hearing, seeing, or moving. Combinations can be weighted to simultaneously address multiple learning modes and to allow the user to select those which prove individually useful.

A fourth criteria is asking how complex is the content? Identification of the scope and complexity of the content will help define the structures for organizing and navigating through the material.

Formative Evaluation

All the above are critical to the definition of a public user interface. Before basic design issues are considered: how screens look, what type of authoring systems are used, hardware specifications, the user issues need to be answered. This entails an on-going involvement with the target audience and forms the basis for formative evaluation in the prototyping process.

A surprising number of projects bypass this issue due to the realities of budget, time schedules, and bruised designer egos. Unfortunately formative evaluation is rarely budgeted for as a necessary phase of design, and therefore is unlikely to take place. Without this critical prototyping phase the museum visitor will have little opportunity to influence the development of exhibits that they will use.

Through this interaction with the target audience, design issues can be explored at a developmental phase which allows for easy redesign or changes in goals or scope. The key factor is the ability to develop content materials (all media - not just printed scripts) to a meaningful level for evaluation without going so far that they can't easily revised.

Navigation / Content Structures

How does this thing work? Probably the most often asked question and the most difficult to address. There are a multitude of approaches to breaking up and presenting content and navigating through it. A basic question forms the philosophy of the design. Is the user in control or is the program? In many computer based training programs testing is an important consideration alongside limited access to sequence of topics. Museums will need to decide if they want random access, linear access, or restricted access. Information can be presented in seven primary modes:

- single screen (all information appears to be in one screen)
- nested topic / subtopic / secondary (hierarchical)
- contextual (virtual reality, object oriented, AI)
- linear (forwards / backwards)
- network / hypertext (any screen / text linked to any other screen)
- animated sequence (no control over sequence)
- rule based

Numerous permutations of the above are possible allowing for using different modes when most appropriate to the content. These modes can also respond to varying interest levels:

- overview (what is in here?)
- browsing (just looking)
- investigation (searching / sorting)
- response (linking)
- review

One of the most vexing areas of interactive design is taking the content structure and mapping this structure to interface designs which complement both the educational and navigational goals. Along with these structures are the development of appropriate metaphors for representing the content including:

- appropriate scale
- comparable depth of information
- realism
- density of information

This design stage benefits from a team approach with creative input from multiple points of view and specialties. A good one-third of the design process is this tug of war between content and navigation structures and metaphors.

Interface Features

Some pivotal interface features appearing in most successful interactive exhibits include:

- the users know where they are in the program at all times
- the users can easily get to the area of interest, while going through the least amount of information to get there
- answers the question "how does it work?"
- consistency of interface metaphors (icons, buttons, navigation structure, sound)
- the appearance that the user is always in control of the process
- content is grouped in a way that the user anticipates the next subject or level
- complex content feels simple
- the navigation structure is appropriate to the nature of the content
- the media used is appropriate to the information density desired
- more than one mode of sensory learning is available
- the navigation process does not interrupt visual or sonic comprehension

Appropriate Media

During the last three years technologies related to interactive computing and their application to exhibit design have exploded. The cost vs. performance ratio has accelerated at a dizzying rate. At first bloom this would seem to represent unending progress, yet we are still in a developmental phase learning how all these new tools work. Nowhere is this more evident than in the use of multiple media, most specifically in random access applications using: text, animation, narration, sound effects, music, video, and still images.

Along with the proliferation of new tools is a more classic dilemma - what is the appropriate medium to convey the message ?. In a world where you can turn narrators on and off, slow the pace, pause phenomena midstream, zoom in or out; the choices can become overwhelming. Each available medium has attributes which lends itself to certain content treatment.

With the ease of pointing a camera and hitting the record button the integration of full-motion video into interactive applications brings up a number of questions:

- does the video used convey the information we desire at the proper scale, lighting, color balance, etc.?
- how do we get video images of phenomena that are too small, too large, moving too fast / slow, have too little light, etc.?

- is the interactivity limited to on-screen buttons running video clips?
- are talking heads useful visual information that help explain the content?
- to what degree should interactive video applications mirror passive TV functions vs. dynamic user interaction?

Repurposing

There is a growing realization that production of original video material for interactive use is so expensive that recycling material made for other purposes will yield a treasure trove of useable content for numerous purposes. There is even a growing industry (witness ABC interactive) which is founded on this concept.

A troubling question arises when one imagines a work such as the Martin Luther King videodisk being planned, and a hypothetical comment is made concerning the lack of pivotal footage because another network covered that event. Would the content be changed, or would ABC acquire the rights to the needed materials?. Is content development compromised by ready access to material which may be close to, but not exactly what is needed?

When it is not possible, desirable, or affordable to use full motion video an alternative is the use of animation or simulation.

Animation

When does animation become the obvious candidate? Animation or simulation offers potential solutions when the literal is no longer desirable or practical. Use of animation sequences offer a number of possibilities:

- conceptual abstractions
- varying degrees of detail
- variable tempos
- higher degrees of user interaction
- simplification of content for greater focus
- combinations of varying scales
- unique points of view
- breaking long sequences into smaller digestible pieces

Particularly in science areas it is common to need stunning imagery that is unattainable in the format needed (i.e. having a static electron microscope image, but needing full motion), or unavailability of particular images.

A critical issue of scale is often overlooked. Sometimes an image is just not available at the appropriate scale. The first response is usually "well, just blow it up larger". This ignores the fact that you need more information, not a bigger image on the page. Some current fractal models demonstrate the ability to zoom in ever closer and still get more and more detail, but presently this is limited to mathematically based images. A classic paradox exists in the comparison of two seemingly identical photographs, but upon close inspection one caption reads "a closeup of a river bed in Arizona," the other "a rock flow on Mars."

A difficulty in presenting users with interactive environments is they often feel the detail and levels of information should be endless without any consideration for the complexity or expense to create such depth.

Simulation

How does simulation differ from animation? Animation is typically approached from a sequential cell animation concept (ala Disney) which allows the visitor to initiate a series of movie-like sequences, whereas simulation necessitates a higher level of interactivity. The user actually takes a role in the phenomena vs. simply initiating or stopping it. Simulation involves the modeling of the phenomena and the potential for greater interactivity and multiple points of view. It also demands a new level of software - object oriented programming which will allow separate objects to respond to other objects in a multitude of ways. Not only must the programmer view the project as a simulated experience, but new demands are put on other members of the design team to conceive of their parts as a contribution to a fluid whole.

Multi-disciplinary Design Teams

A museum wanting to create interactive exhibits in-house needs to consider the flexibility of their staff. Creating an in-house design and production team means the project manager must be familiar with the issues of:

- software design specifications and performance
- hardware specifications and performance
- interface design
- content hierarchies
- use of appropriate mediums (sound, animation, video, graphics, text, narration)
- contractual / copyright liabilities
- maintenance issues
- evaluation
- kiosk design

The standard issues of project management - staffing, scheduling, and fiscal responsibilities also play an integral part. Scheduling of interactive projects is a subject beyond the scope of this paper, but critical to the success of the project.

A design team can consist of between one to twenty or more, but because of budget and production considerations the smaller the better. This team is often made up of: content specialists, writers, graphic designers, software designers/programmers, sound/music designers, animators, video/audio/computer technicians, and other consultants and advisors.

The balance of talents and tasks varies greatly depending upon the individuals available and the budgets available. Since making an interactive exhibit demands integration it is extremely important that each team member recognizes the value and contributions of the others. These projects often fail based upon their weakest link - cooperation.

Too many specialists can be a recipe for disaster. Each will try to lobby for their specialty and its ability to carry the project. A project manager who is able to oversee and balance the functions and abilities, and gingerly massage the process down the road on time and on budget is a rare breed as well.

Designing interactive exhibits is not a science, it is constantly in flux and responds to changes in software, hardware, and interface design, and the demands of more experienced users. The best design group is motivated to respond to the visitor, change directions when necessary, and is excited by what is around the next technological bend and how this will help communicate the subject matter.

Controlling the Interface

Once we get all these elaborate elements in place, how does the user control the exhibit? The evolution of controlling computers has had curious twists. Early on came the keyboard which mimicked the typewriter, for computers at that time were large calculators. Xerox P.A.R.C. then introduced the mouse along with the concept of the computer as a visual medium. Almost 25 years later we still primarily use the mouse and keyboard. Central to the issue of controllers is the information they control. Using keyboard keys to control audio functions simply is not appropriate. How do we access time based media such as video or animations? When we move away from the computer as solely a visual instrument with a screen, new possibilities arise for exhibit designs.

The most common controller at present is the touchscreen, which has drawbacks including: relatively high cost, dirty screens, parallax problems, viewing the hand in front of the content, and limitation of finger size and capacitance. The touchscreen is again going back to the typewriter - still holding on to the use of metaphorical buttons as access to multi-sensory information.

A breed of new controllers have emerged some modifying the basic mouse, and others pointing to new directions including:

- lightpen and pen based tablets
- trackballs, joysticks, control wheels
- ultrasonic devices worn on the head (turning to greet a visitor could have disastrous consequences)
- eye trackers (tracks the position of the eye's pupil and translates the data into screen coordinates)
- data gloves (responds to position of hand in space and articulation of the fingers - Nintendo Power Glove and VPL DataGlove)

- position sensors (locate the position of a hand / or head in a defined space - Broderbund's Uforce and MacDonald Douglas' Polhemus sensor)
- 3D / 6D controllers (University of New Brunswick Bat, Spatial Systems Spaceball, Sim Graphics Engineering Flying Mouse, Sensor Frame Corp. Sensor Cube)
- natural speech commands (coming, coming and still coming)

A number of kinesthetic issues arise, largely due to the inability to represent force feedback (with a DataGlove you can hurl yourself through a wall at great velocity when you relax the wrong finger by mistake). Picking up a simulated chair with no weight misses essential feedback about gravity. Very little work has been done in the area of smart knobs - ones that respond appropriately to the task (i.e. turning gets harder as the load meets resistance).

Sonic directions

Until the last few years the digital computer was not a stunning performer when it came to the sound domain - graphics was dominant. Even though Apple Computer built sound functions into the Macintosh, it took almost five years before the use of sound with computers reached and surpassed the analog audio potential.

Current hardware and software combine to allow flexible recording, mixing, editing, signal processing, sound synthesis. CD quality is now easily achievable with moderate expense, and in the next two years will be cheap. Compression of sound files is underway and synchronization of sound files to animation and video will allow sound to be imbedded in new "compound" documents and presentations.

One missing element is the use of binaural sound. Binaural recording has been around since the mid 1940's and uses microphones placed at the ears. The sound is recorded as the ear would hear it, and when played back over headphones has stunning localization. All of a sudden we live in the middle of a sound environment as we normally do. Sounds move overhead, from behind, skim along the ground and, in contrast to an artificial left/right stereo, they become dynamic in space. With the proliferation of headphone use today this is an area which is ripe for development. The Ames Research Center at NASA is presently the leader in developing a synthetic binaural experience - making it possible to place any sound anywhere in a sonic architecture.

At present, few of these audio capabilities are built into interactive exhibit development largely because of a long time bias towards text and video. Sound localization cues can greatly enhance our understanding of certain phenomena. For instance, we now have simulated architectural walkthroughs. Imagine as you walk through the space the sound of your footsteps and voice changing as does the architectural view. Consistent use of sound cues can reinforce interface metaphors and navigation, and help users who are more receptive to auditory sensory modes of learning.

Future Developments

On the surface these are fascinating developments and truly hold promise for more than an enhanced shoot-em-up video game; but a great deal of effort must be put into the human factors, the potential for ease of use, flexibility of control, and application to appropriate content. Many of these devices are just now allowing us to break new boundaries in controlling a new world of simulated realities.

A project is underway at the New York Hall of Science in Queens, N.Y. to create a series of new interactive exhibits on audio technologies. A few potential applications of new controllers and their consequences to a public interface may be:

- an original Edison wax cylinder being played by laser (allowing the public endless use of the cylinder with no wear, and random access to any point on the cylinder along with the ability to transform pitch, repetition, and rhythm by moving the laser along the cylinder)
- a walk-on sound mixer with 16 tracks of music controlled by two video cameras and software which could recognize the visitor stepping on one of the simulated tracks and activate that particular track of the multitrack recording (movement recognition would be in software allowing the system to respond differently to one or thirty - solving a common problem with interactive exhibits)
- a set of binaural headsets - headphones with microphones attached, are placed at two towers a distance apart allowing two visitors to trade ears with each other (each hears the head movement and sonic perspective of the other)
- an aural history of audio devices (the visitor steps up to a range of audio devices through history and speaks into a microphone.- they hear their voice come back through that device along with the attendant noise, distortion, and filtering - presenting the evolution of audio technologies as a sonic phenomena vs. text or visual)
- a set of manipulated "sound" blocks (blocks which can be arranged and manipulated on a tabletop to mix each sound associated with a block when the blocks are stacked one atop another, or play the sounds in sequence if the blocks are arranged in series or a mixture of both).

It is clear that the future directions of interactive interfaces and exhibits will use more extensive input from the user including physical gestures, voice, eye movements; and the exhibits will respond in multi-sensory modes with the ability to place the user in articulate control of the experience. This is a large challenge to the button-pushing interaction of today, but with attention and patience to detail it will radically transform the field of exhibit design.

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Multimedia in Public Space

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Abstract The intersection of interactive multimedia and public space environments such as museums provides the opportunity to examine some of the fundamental environmental qualities of both domains. Public spaces are clearly public, spatial and timeless. Multimedia is multisensorial and provides for controlled segmentation and group experiences. Both focus on the interactive experience. The key to good multimedia design in public space settings is to examine the relationship between the nature of the interactivity and the objects within the space as well as the space itself. This paper presents a framework for analysis and some suggestions for good design practice.

Introduction

This is a study at the intersection of two exciting domains, multimedia and public space. Just as the juncture of computers and media such as film, audio and graphics, what is called "multimedia," has lead to a re-examination of the potential of both these media and computing, the juncture of multimedia and public space can lead to a new understanding of these fields and how they can be combined. Designers who ply their trade in public environments and multimedia have a lot to learn from each other and to contribute to each other as well.

Interactive media have been the staple of public space for years. From the news kiosk on the corner and the shop windows down the street to the museum exhibition, theme park experience or the information display at the local airport, designers have used a mixture of images, sounds, texts and graphics to provide a mixture of education and entertainment which affect our everyday life.

And public space is big business. There are over 10,000 museums and visitor centers in the United State alone. Over 50,000,000 people visit science centers annually -- more than attend all professional sports combined. And every day, millions of people pass through city parks and squares, airports, transit systems and public buildings, either on their way to somewhere, or to enjoy the environment and the people they contain. Millions of dollars are spent annually on information, education and entertainment systems which fill these public spaces.

The use of multimedia computing has also exploded during the past few years. The introduction of new and simple tools such as Apple Computer's HyperCard, CD-ROM players, NTSC video display hardware and the improvement of consumer and professional video and audio equipment has fostered the increasing integration of computers and computer generated graphics and text with sounds and images. More and more people are designing and using multimedia systems in their workplace, in education and for entertainment. As a result the true power of the active manipulation of pictures and sounds is just now being discovered.

Although diverse in nature, public spaces have a few elements in common that appear to be essential to their success. They are public; that is, they are social, people come to them with other people, to interact or to watch other people doing things. They are spatial; the nature of space and how people use it is key to their design. And finally they are timeless, or to put it another way, the timing of interaction is exceedingly variable and idiosyncratic with the participant.

The extension of personal computing into multimedia results in certain features as well. These systems now support group experiences; activities where a number of people can interact with one system. The experience can also be multimodal, providing a mixture of real images, dynamic models, rich sounds and tactile sensations. Finally, the media information and experience can be segmented under the control of the user. A piece of video can be viewed, reviewed, stored and then retrieved for a new purpose.

All of these features make the merging of public space and multimedia computing exceedingly interesting from an interactive designer's point of view. Public space offers to multimedia designers an exciting environment to work in with rich content and contexts and a group of practitioners who understand fundamental issues concerning human interface design and true interactivity. It is important to note that the nature people's interaction with computing systems in public spaces is fundamentally different than it is in school or office settings. Often people are standing, visiting in groups with mixed ages and passing by with little time or sympathy for learning an interface.

Multimedia offers to people working in public space a set of new and exciting tools to augment their 3 - D displays and a way to extend the experience of visitors to greater depth and other environments. Through access to rich interactive kiosks in museums, for example, it is possible for visitors to move from a glancing experience to a deeper involvement with an underlying idea. The potential now exists to extend at least part of the public experience with all of its drama and senses into the private world of the home.

Thoughts on the Nature of Public Space

Multimedia producers need to come together with public space designers to test strategies that have impact on a public audience. To proceed with our particular projects we need to explore the questions and considerations that arise when the human mind, technology and environment interact with one another. We need to examine projects that have put computers in public spaces and learn from the veterans of the logistical and economic trenches how we might combine design elements effectively.

Environmental psychology, influenced by the multidisciplinary academic trends in the early 1970's, attempted to show public space designers how to anticipate human use of architectural settings. At the environmental architecture group at UC Berkeley, we tried to articulate to designers a representation of human experience through prototype environments. We constructed a model of a town and devised probes for discovering the affective experience of a particular site before construction.

With multimedia technology we have a similar puzzle: Place a computer box of interactive experiences into an unknown situation; what are its effects on human experience? We have a "Trojan Horse" opportunity, a small box holding powerful changes. How do we design for the elements of human awareness? We have a clue: Computer use has the clear potential to be a group experience and can ideally support collaborative work.

Computer developers have traditionally designed the computer encounter with little concern for where it will be experienced. Physical conditions, such as lighting, colors, eye-level heights, or conditions of social interactions, such as the number of users and the nature of their acquaintance with computers or each other, are unknown. The assumption of a single user at a desktop monitor doesn't hold in a public place setting.

Accessibility is crucial. The Apple dream is to make computer information and tools available to the populace at large, and placing computers in the public environment allows the expense of technology to be absorbed by site sponsors. Education is the transfer of information from one organization to another, and interactive installations can expand the educational functions of many familiar props, of the information kiosk, for instance. Decentralized personal computers, equipped with software for analysis of large stores of data, text and images, will allow more people to study complex problems and participate in solving them, even while at an airport or an exhibit. The public, with computers, can participate in policy making by educating others, as well as being educated.

What is the nature of interactivity?

Cybernetics, the study of communication systems and their interactions, has already been developed for public space by museum people who must anticipate how patrons will move through an exhibit. Similar to "mousing around" on a computer, in a museum "the feet do the browsing". The layout of information is with respect to space. Interaction with information is not controlled as in film or narrative storytelling; people ask what they want and go where they want. Multimedia design must accommodate the fact that a computer is not just a box, it is responsive, it has a "where-ness". We must devise navigation schemes for traversing information. We are not dealing with just text and graphics, we are constructing multimedia "objects", compositions for use in other situations. Which techniques might be transferable from a museum floorplan to an interactive format?

What is the nature of public space?

It has staying integrity, yet it is reshaped by use, transformed by participation. The best designs engage people, encourage new experiences, prompt personal actions, even though public space is entered primarily to get somewhere else. Can we create virtual environments with electronic media and achieve the same coherence of movement and sturdiness of objects as in a physical space?

What is the nature of time?

With computers we expect information on demand, we want to have a response now. In a public space we have only brief interactions, including structured events. How do we negotiate this contrast between "on demand" vs "ritualized" human experience? Souvenirs become the important link: we can take something home with us and construct a more sustained, personal interaction with the experience. We can go to an event in a public space, then go to a private space for more depth and to investigate references. We should have the technology there, at the exhibit, the classroom, the playground and at home, so we can take these experiences with us and build on them.

A Framework for Multimedia in Public Space

There are many ways in which multimedia applications fit into public space environments. Sometimes access to a multimedia database can provide an important context for an exhibition. Or a large screen interactive video presentation can provide an exciting group experience. Different multimedia projects perform different functions and an individual institution or location may have a variety of different ways that multimedia is used. To help focus the discussion of multimedia in public space on some of the fundamental design issues, it is helpful to view these various public space applications in a framework which relates the nature of the interactivity to the relationship of the multimedia system in the space itself. It is important to understand this relationship because the specific design of a multimedia element and how well it works often depends on the particular setting and its relationship to the whole environment. Larry Friedlander's paper which follows on the development of an interactive exhibit space for the Globe Theatre Project in London will serve as a good set of concrete examples of what we are discussing here.

There are a variety of ways to use interactive multimedia in public space and in many of them the nature of the interactivity is quite different. The chart presents some of these interrelations. The horizontal axis describes the nature of the interactivity. For example, one common and important use of interactive media is to support the passive presentation in an accessible way. The hallmark of this application is the existence of few choices and somewhat lengthy interactions. Examples might include a selection of short films on the life and times of a particular artist whose work is being exhibited or audio programs of railroad sounds associated with an exhibition on steam engines. The system is designed to play clips of video or audio, 5 to 20 minutes in length or maybe longer, which support the context of a particular exhibition or location. The visitor can select which clips they want to see at a particular time. Since interactive video and multimedia systems have fewer moving parts than film or videotape machines, they offer greater mechanical reliability. This is an important consideration in a public space setting where the staffing is minimal, and many of the audio/visual presentation are self actuated. And since the interaction time is long, the physical comfort of the viewing space is important.

In some cases it is desirable to take a tour through an exhibition or location. These guided experiences can be provided by a walking audio or videotape tour or a radio receiver handset receiving location specific stories from a low power transmitter. With this application the interactivity is already significant because the visitor can stop the presentation at will and review the material by rewinding the tape. This experience can be used to give visitors a guided tour through an art exhibition or to provide atmospheric stories and sounds at a collection of historic ships. The personality of the guide and his or her knowledgeability and genuineness is critical to making these applications a success.

In an interactive browsing system, the visitor is able to browse, often quite quickly, through many pieces of information before working through a particular set of images, text or sounds in detail. The part of the system you view at any one time may be only a small portion of what is available. This multimedia database can be outfitted with all sorts of maps, guides and indices. For example, a database of images and background text may support an exhibition of historical objects. Or an informational kiosk at a busy downtown location could provide information about the cultural or historical facilities nearby. Here, the framework for navigation becomes an essential tool because of the volume of data available. In this kind of application the program elements have to be brief and easy to quit and the interface design has to be very transparent and easy to master because the visitor allocates only a brief time to master it before they move on to something more compelling.

Finally, at the far end of this axis are activities where you interact directly with the imagery, text and sounds. Youre making your choices directly with the media through direct creation and not from a menu or from some kind of a database navigation system. There is little if any mediation between you and the material. These multimedia systems allow you to create your own investigation, your own media project. A videodisc flyover of a city allows you to create your own tour and to examine in detail a neighborhood of interest. Or by using a simple computer based editor, you can combine a set of sounds and images related to the objects in a history exhibition to produce your own video catalog to take home for further viewing. The richness of the presentation and the immediacy of the interface is key for these applications. The vertical axis of the chart represents the physical and/or contextual relationship of the multimedia installation to the exhibition. At one level the interactive media project may serve as an adjunctive resource to the exhibition, located typically in an attached library or resource center in the museum setting. Visitors who are interested in exploring ideas in depth or dwelling on a particular set of images presented in an exhibit are able to access additional text and visual material and view it at their own pace on workstations in this center. The separation from the primary activity with its distractions can allow for longer and more concentrated interactions. A special resource room near to the exhibit floor and outfitted with multimedia workstations, activity tables, a stockroom of props and large projection screens for group viewing might serve as a lively instruction space for a class on a field trip to a theater museum. Different versions of plays along with sets and costumes could be presented and discussed. And an information kiosk in the lobby can have information about other cultural events in the city that the visitor might find interesting.

Multimedia workstations can also provide information through a mediated experience in the direct context of the exhibit on the exhibit floor itself. By using an interactive multimedia kiosk near a set of exhibits a visitor can learn more about the exhibit and answer questions that may have been stimulated by viewing the exhibit. For an exhibition on light and color, the workstation could have animated diagrams of the physics of making color as well as many examples of color formation in nature. This application supports a fluid back and forth relationship between the exhibit and the multimedia system. The visual connections between the exhibit or space and the material in the workstation needs to be very strong. And one has to pay exceedingly close attention to the physical relationship between the interactive system and the other exhibit elements. All too often the video monitor sticks out like a floating electronic sore thumb, a foreign afterthought in the midst of the exhibited objects.

The multimedia station may also become the primary exhibit itself where the interactive video may provide the main experience. A video showing the slow motion action of a playground swing or merry-go-round becomes an exhibit on mechanics. A multimedia system can provide provide the visitor with the ability to magnify and analyze an image; compare it to others or to experiment with changing lighting and color mixing in relation to a painters work. These kinds of presentations are some of the most challenging ones for designers. It is important to think beyond the computer as a box with a monitor on top. Large scale projections, multiple monitors and dynamic mechanical interfaces to other objects can provide exciting interactions.

Finally, the last category consists of providing a visitor a takeaway experience through the production of a video or audio tape, a videodisc, CD-ROM or a catalog. Interactive media then becomes an extension of the exhibit itself, one which allows the visitor to take a piece of their public experience home with them. Videodiscs already exist of the collection of a few major art museums and city architecture. A videodisc and software from a museum might be used by a school class to develop reports after a field trip. And a visitor produced multimedia presentation which can be recorded at a pubic space site onto videotape can be taken home for viewing. As multimedia platforms become more common, it will be possible to sell take home experiences which enable visitors to study exhibits in more detail at their leisure.

For all of these applications, the one essential criteria for success is to include designing the multimedia elements in the overall exhibition or space development right from the start. Too often these stations can appear to be just an add on, subtracting from the experience rather than enhancing it. The material and the architectural design are the prime elements that should drive the multimedia development.

Future Directions

In addition to fueling the general development of multimedia, the public space environment will stimulate a number of specific hardware and software developments. The first is in the area of large screen and multiple screen projection systems. The general scale and group dimension of these environments naturally leads to innovative use of interactive and multiuser projections. And public environments are capable of supporting the hardware necessary for these kinds of installations. During the development of the Globe Theater design example at the Apple Multimedia Lab we experimented with interactive projections where you could act with actors on stage and get a video of your "screen test" to take home with you.

The second concerns the development of interface hardware and software which can stand the rigors of heavy use by inexperienced. A new generation of touch screens and trackball interfaces are being developed for public environments along with interface metaphors which are naturally easy to use. The interrelationship between exhibits and multimedia systems will lead to the further development of simulations and graphic modelling which directly visually couple to the exhibit elements as well as information kiosk systems which help visitors to navigate through particular spaces and get detailed contextual information supporting a particular exhibit.

Finally, because public space environments can support the hardware and software of multimedia today, museums and other such sites are ideal places to establish store front multimedia centers where visitors can experience multimedia computing for the first time. In a similar way to the creation of computing centers for visitors that were established in museums in the 1970's before personal computing became a reality, these multimedia centers will allow a wide audience to work with computer controlled images, sounds and text. As we stand at this crossroads of multimedia and public space, let us meet to get the conversation going. As we share what we know of specific projects, methodologies, and economic strategies, we will gain from our different points of view. The outcomes will not only be better projects for multimedia and public spaces, but hopefully a better understanding of the more general issues surrounding the pubic use of interactive computing power.

Evaluating Museum Visitors' Use of Interactive Video

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Abstract

This paper describes the evaluation of an interactive video system exhibited at the Resistance Museum in Copenhagen. The system contains films and an image database of about 11,000 photographs.

The evaluation concentrated on four main themes:

1. The users
2. How the system was used
3. What the visitors thought of the system
4. The system in relation to the exhibition

The evaluation was conducted using observation, interviews, and questionnaires. The result of the evaluation is published in a report (in Danish, however) and the main points are referred to in the paper.

When you have spent a fortune on creating an interactive video system, it should be quite natural for you to evaluate it afterwards. And not only to find out if the money was well spent, for if turned out to have been a total flop, there wouldn't be much to do about it. Hopefully such failures are rare. Evaluations can also be very useful in gathering experience that will benefit future projects. Published evaluations could be very helpful, not only at the same museum, but also at other museums planning a project, perhaps for the first time.

At the National Museum of Denmark we produced an interactive video system with the title, "Danish Resistance during the German Occupation 1940-45." A department of the museum specializes in this period and has its own exhibitions in its own building, called the Resistance Museum. The main aim of the system was to supplement the exhibitions by giving large scale access to some of the photographs and artifacts that we are usually unable to exhibit. To this material we added nine 3-minute video sequences presenting central items within the history of the resistance.

It is not difficult to put short videos on a videodisc and to then make an accompanying computer menu from which to choose these videos. The question was: How to organize 11,000 images and make it possible to choose among them in a meaningful way ? We wanted to keep the system so simple that everyone without knowledge of such systems would be able to use it, since the target group were casual museum visitors. In this case we decided to register every single image without regard to its relation to other images. The fields in the database (seen by the user) were: a caption, two items, a date, two places and four descriptive key words. Since the captions were not to be used in searches, this gave us nine fields to search.

The situation is as follows: The visitor is attracted by the system and touches the data screen to start it (the user navigates through the system via a touch screen). The first choice is between films, photographs and artifacts, and leads to new menus. Within the photographs section, the system presents a menu of items and a map of Denmark, so that a certain region of the country can be pointed out. When the first photograph is displayed, the visitor can then browse through the collection of images associated with the selected item or region. Besides this, the nine searchable fields can also be used to search new collections of photographs. A combination of up to three fields is possible. In this sense, the system is a little complicated, and it is difficult to explain how it works. Because we didn't want to put a manual with it, we had to put all the information on the screen.

Once the system became part of the exhibition, it was kept under observation for some days in order to make sure that the system and equipment functioned as expected. After three months, a formalized evaluation was made. Since the resistance videodisc was the first one produced by a Danish museum, there were many questions, not only about the construction of the system, but also about the users. Our evaluation concentrated on four main themes:

- 1.Users and non-users. Which visitors used the system? Which ones didn't, and why not? (Age, sex, nationality).
- 2. Visitors use, as observed. Which part of the system was chosen? How much time was spent on each part, and on the system as a whole? etc.
- 3. The visitor's judgement. Comments made by visitors using the system were noted.
- 4. The system in relation to the permanent exhibition. Did the system steal attention from the exhibition, or did it function as a supplement and enhancement?

Within a 2-week period the formalized evaluation was carried out partly by observation, partly by interviews, and partly by questionnaires. Unfortunately, there is no logging built into the system, which would have been quite helpful, especially for the second theme (visitors use). But the system is rather complicated and it would probably have occupied too much of the computer capacity to make a really diffentiated logging anyway.

The first theme was investigated by means of questionaires and interviews. One questionnaire was given to all visitors, in order to contact the non-users as well as the users. Among other things, the visitors were asked how long they had spent at the museum and if the interactive video system had been used. If the answer was negative, we asked why (fig 1).

We investigated the second theme primarily through observation. An extra data screen was placed at a distance from the system, so that the observer could watch how the system was navigated, which parts of it were used, and whether or not the visitors managed to understand the functions. One might fear that the visitors felt uncomfortable about being spied upon, but since all observed users were interviewed afterwards, we are certain that it was not a problem. The observer filled out a scheme during the observation, and afterwards conducted a brief interview asking for positive and negative opinions about the system. This interview, together with a questionnaire given only to those who had been observed and interviewed (fig 2.), formed the basis of the investigation.

It might seem redundant, observing, interviewing and distributing questionnaires concerning some of the same questions, but sometimes we found contradictions between what was observed and what visitors answered. One example that should be mentioned is an explanatory display which was placed near the system for a short time. Some visitors found this display "very instructive," though it had been observed that they actually hadn't read it! This reminds us to be careful when accepting answers uncritically - especially the polite ones.

The last theme, the relationship between the system and the exhibition, was elucidated by the statements on the questionnaires as compared to earlier studies of visitors to the Resistance Museum. The final results have been published in a report by the coordinator of the evaluation (Henrik Lundbak: Sger! - og I skal finde, 1990). The main conclusions are as follows:

Users and Non-users

One third of the museum's visitors did actually use the system, and another third would like to have used it if it hadn't been occupied. The rest hadn't noticed the system, hadn't had time or weren't interested in it. The users seemed to come from a broad section of visitors with variations in nationality, sex and age, except for a small bias shown toward the elderly public, as expected. It was also expected that children would occupy the system a good part of the time, and they did, one eighth of the time. Guards usually keep an eye on the system and prevent children from occupying it too long, but of course children are visitors as much as adults are, and must have access to the facilities of the museum like everybody else.

Visitor's Use

Visitors were observed to use the system for as long as half an hour, but half of them spent less than 5 minutes. The "serious" users would spend about 7 minutes, and the most popular choice was to look at films. However, if considered as one image database, photographs and artifacts attracted 2/3 of the users. It seems that most of the users actually did utilize the ability to make their own searches using the key words, although it was not explained on the screen.

On the other hand, only a few visitors got the idea to point out regions on the map. A built-in function makes the system return to the starting position when it has not been touched for a while, in order to facilitate the next visitor's use. The evaluation showed a significant difference between situations in which the user started from the starting position and those in which the user started from where another visitor had left it. The last situation caused many more difficulties.

Visitor's Judgement

Up to 80% of the visitors found the system easy to understand, informative and to some extent entertaining. We received some good suggestions in the free comments about ergonomic matters like screen size, having more than one system, having chairs, the sound level, etc. Some users, probably experienced computer users, had suggestions for the program such as smarter browse functions and possibilities for more specific searches. Such statements emphasize the difficulty in creating systems to satisfy experienced as well as inexperienced computer users. Since the latter group is still the largest, the systems should be adapted to them, at least as long as we are talking about exhibition systems. But in the future, visitors will probably be more critical and make more specific demands on interactive systems, following the growing use of information technology in museums and society in general.

The System in Relation to the Exhibition

A portion of the users appreciated the possibility of choosing information according to their own interests, and considered the system an alternative and supplement to the permanent exhibition.

One objection to using interactive systems in exhibitions, commonly voiced by the museum staff, is the fear that the technology will become the main attraction at the expense of the artifacts. Our evaluation has shown that the visitors who spend the most time at the system also spend the most time in the museum; however, not all of their time is spent at the system. The average lenghth of a visit to the Resistance Museum is 40 minutes and since most of the visitors spent less than 10 minutes at the system we can conclude that it is used as it was intended to be used: as a supplement to the permanent exhibition.

Image Databases for Museum Staff, Visitors and the Outside World:

The Same Basic Material?

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Abstract

This paper deals with different kinds of image databases in museum surroundings. Based on the experiences of the National Musuem of Denmark, different target audiences are mentioned, which require different user interfaces, from illustrated text databases (collection mangement systems) to highly interactive image databases for unqualified visitors. The question arises as to whether it is possible to adapt the same basic material to the different user levels, or to what extent new recording material is necessary. Furthermore, the role of images in systems is discussed. How do we avoid images becoming dead ends in the systems? How do we make them searchable, and platforms for "association jumps?"

The National Museum of Denmark is a cultural historical museum covering Danish history from prehistoric to modern times, anthropology, antiques, coins, open air museum, conservation etc.

The museum is in the middle of an extensive rebuilding project. The purpose of the project is partly to create new exhibitions and facilities for visitors, but another important part (called the Documentation Project) is to make information available for visitors as well as the outside world, e.g. education. "Information," in this case, means all the knowledge existing in a museum, but normally hidden in archives and storages. Two important means of making that information available to a broad public are text and image databases. But before dissemination of information is possible, it must be assembled on a media well suited to electronic distribution.

Since most departments have been or will be involved in the documentation project, which runs over 7 years, it has not been possible for all departments to reach the same stage at the same time. This has turned out to be an advantage, since it has made it possible to test different approaches to recording and dissemination. We have had the opportunity to consider the nature of image databases as a result.

During the last three years, we have established text databases of almost half a million artifacts, of which about 100,000 have also been registered photographically. Consequently, we claim that we have an image database, in the sense that an image database is merely a text database containing images to be seen with text. An illustrated text database, so to speak. For the user, the image serves as another field to be retrieved from the database, but we know that no field in the database contains an image in itself, only an external reference to the place where the image is to be found by the computer program. It is, of course, important that the image be stored in a medium which gives the user immediate access to it. The image itself, however, does not provide for any further possible qualified searches as do the other fields in the database, such as measurements, materials, or codes of function and origin, all of which give us written information about the artifact.

The pictoral part of the database is an appendix, in a sense. It primarily serves an administrative function similar to storeroom information about the artifacts, or information about where to find the records in the manual archives. By establishing image databases of this kind, we can free ourselves from dependence on manual photoarchives. Now we can simply call forth the images on the monitor instead of going to the archive drawers. In our case, the images are photos of the artifact, but they could just as easily have been photos of the protocols or other related documents.

How lucky we are, that technology allows us to transfer images along with text when we establish electronic databases, especially since the combination of text and images has already been in use for many years in our manual archives! Explained in this way, an image database seems to be of obvious benefit, since a photo of the artifact is a necessity in an artifact database. Anything less would be a step backwards, since manual archives have been replaced by databases.

At the National Museum, all 80,000 artifacts from the Ethnographical Department have been text registered and photographed. The images are stored on a two sided Laser Vision videodisc. The database functions in two ways. First, you can search the text, and when the appropiate records have been found, you can look at images related to the text. The other way round, you can browse through the images and, after having found some interesting looking artifacts, you can retrieve the descriptive text. This database is useful to the museum staff working on plans for new exhibitions, especially in situations where the artifacts are stored away and not physically accessible. One record, describing one artifact, consists of up to 60 fields, 15 of which are currently searchable, including the address of the image. What we are talking about is simply a collection management system with familiar possibilities for searching and retrieving information. The browse function, however, focuses on the images and gives us a previously inaccessible visual perspective on the whole collection. With 105,000 pictures in the database, it would take about 10 hours to browse through all of them using the slow step function.

It is important to remember that museum databases are usually computerized catalogues, formerly written on cards or in books. Will visitors enjoy having access to this kind of information?

It is often claimed that a picture is worth more than a thousand words, and it *is* true that a picture can create a series of associations. But these associations are rarely articulated in words, and in the administrative database there is seldom room for registration of such things. Nevertheless we have, at the National Museum, attempted to create a system for less determined users: the visitors coming in from the street. If we imagine for a minute that visitors are not primarily interested in computerized catalogues of the kind just described, what exactly do we need to make image databases more attractive and exciting?

We have to find out how we can integrate the images in the search process. As far as I know, it is not possible yet to create real picture driven databases, which allow you to point out any area of a picture and make it the parameter for a new search. In its most extreme version, such a database would involve pattern recognition on a scale which is not realistic right now. And besides, how would the system know what the user expected to see when an area was activated? Take an image of a hat. If the user points out a certain area, what kind of information could he then expect or hope to get? He or she might be just as interested in the material, the pattern, or the techniques used, but the computer still does not know which aspect the user wants. Maybe in the future the data programmers will be able to provide us with expert systems in which the image databases can recognize users and build up a universe of experiences for each individual user. Until then, we will have to use the written languages we have in common to describe elements of the images.

One way is to create links by hand, as has been done in some interactive video systems. By pointing at certain elements of an image, you are led to supplemental information, an explanation or a similar image. This kind of links will, however, always lead to an element of information which has been selected by the designer of the system. A system like that seems to be very flexible and dynamic, but what you really have is many possible combinations, all of which have been foreseen by the designer. Without doubt, creating such links by hand is a comprehensive task. A large scale image database is not well suited for such a treatment, and it is not possible for a human being to think out all possible combinations of the images. Which is fine - that is exactly what computers are for.

One year ago, The National Museum launched its first interactive video system for visitors. The title is "Danish Resistance during the German Occupation 1940-45." All of the material comes from the Resistance Museum, which is a department of the National Museum. The system is presented on two screens, a video monitor and a touch-screen, which operates the system. At the main menu the user can choose among "cinema" (looking at short films), "photographs" (exploring 4,000 photographs from the history of the Resistance) and "artifacts" (looking at objects from the time of the Occupation).

If the user chooses "cinema" a new menu will present a choice of titles. Each title leads to a 3-minute film, which can be stopped when desired. In terms of image databases, the other two selections - photographs and artifacts - are much more relevant. We operate with two different bases for practical reasons, though both databases operate in the same way.

The main entrance to the databases is by item or (for the photographs) geographical criteria. When you have passed through 2 or 3 menus, which can make your choice more specific, you will see the first image on the videoscreen. You can then browse through all the selected images. Accompanying each image on the computer screen is a short description of the artifact or the situation shown in a photograph. The right side of the computer screen shows a column of nine key words, which can be used to jump to other series of images described by the same key words. The key words describe classification, date, place and theme/subject of the image. A combination of up to three key words are allowed when starting new searches. The fascinating aspect of the program is that nobody has arranged the order in which you see the images. Each photograph or artifact has been registered one by one, and it is up to the the user to make his or her own way through the images, using the key words as springboard for what we call "association jumps." Of course, associations are limited to those planted in the system by the designer in the form of key words, but it is important to note that the springboards - not the routes - have been planted. From every single image with nine key words, in combinations of up to three words, there are 129 different possibilities for jumps to other images!

The impressive thing about image databases in museums is that by means of an optical storage media and the computer, you can do things that would not otherwise have been possible. In this case we are working with 4,000 photographs, 6,000 artifacts, and 1,000 archivals. How else could we have exhibited 4,000 photographs in a meaningful way, with several different forms of access and possibilities for combinations?

But the crucial problem is the basic material. Is it sufficient to be used as the nucleus of a system following the hypertext principles described above? Our experience with the Resistance system showed that we got into real trouble when we used the computerized catalogues just as they were. We did that with the artifacts, and the result, we must admit, may look rather poor when seen by an unqualified museum visitor. The information is scanty: the name of the artifact, a museum number, a date, a place, a classification and the names of the donor and user (which probably wouldn't be displayed) etc. That's all. The average visitor lacks context information: how was the artifact made? how was it used? What were the ideas behind it?

With the photographs, we had to record every photograph from scratch, and the result was much more satisfying, since the recording could be adapted to the design of the system. We were able to have a comment and almost always 9 key words for each photograph, while the artifacts are only accompanied by their names and a maximum of 5 key words. Because of this, though, it was difficult to combine the two databases. If you entered the artifacts once it was very difficult to go back to the photographs, so we chose to separate them from the beginning.

Should it be concluded, then, that traditional museum records are not well suited at all to dissemination to wider circles? The answer is yes *and* no, depending on the target audience. One of the most important things to remember is that different target audiences require different applications.

At the National Museum we operate with at least three levels of users. On the first level we have the professional museum staff, on the last the unqualified visitors, just walking in from the street to take a look. The users who make up the level in between might be characterized as qualified visitors, mostly amateurs with special interests. We are planning to establish documentation rooms and a kind of open storage or study collections with access to the databases for them, much like the application for the museum staff, but with access to only some of the data fields.

Likewise, outside the museum, there will be target groups with interests on a higher level, especially in the educational world. In the case of the Resistance video disc we have made an attempt to reach that group. The video disc and floppy discs with basic information about each image is sold at a moderate price. Included in the package is a sheet with bar codes, so that users without computers are able to use the disc in a meaningful way by means of a bar code reader. There are bar codes for each video sequence and about 110 bar codes for access to items in the three groups of material: artifacts, archivals and photographs. The publisher - the Danish Broadcasting Company - has also prepared some educational material that provides a guide to the video disc and suggestions for its use in the classroom. We already know that the video disc has been used by several schools and that teachers have made their own bar codes and hyperstacks to use with it.

This very positive experience is enhanced by another one, which should be foreseen by museums disseminating information on a large scale: the user's ability to check and find incorrect information. Some errors have been found in the Resistance videodisc, particularly wrongly placed photographs. Time will tell if large scale publication of images on videodiscs will create extra administration for the museum staff afterwards. Perhaps we should both hope for and fear it.

How People Use Electronic Interactives:
"Information Age - People, Information & Technology"

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Introduction

Electronic interactives are a powerful new method for communicating with museum visitors. Although museum professionals differ on specific uses, most agree that such devices can be valuable additions to traditional display techniques. They unquestionably attract visitors. But how do visitors use the interactives? How much do they use them? How does their presence affect visitors' experience with traditional displays? In this paper, we will reflect on these questions as we describe what we are beginning to learn about visitor behavior in an exhibit at the National Museum of American History called Information Age: People, Information & Technology. This exhibition not only has many different sorts of interactive displays, but also a network that monitors user activities at a dozen of these stations.

Description of Information Age

Information Age is a 14,000 square foot permanent exhibition. It traces the evolution of electrical and electronic information technology and how it has affected American society. Chronologically it spans from Samuel Morse's invention of the telegraph in 1832 to the computer networks of today. The exhibition has around 700 artifacts, including Morse's original telegraph, original telephones made by Alexander G. Bell, the ENIAC computer of World War II, the first electronic fingerprint computer, a working automotive robot, personal computers, and a high definition television. It also has over 700 graphics, 20 mannequins, and 3 environmental settings. The label copy runs about 90 pages long.

Interactivity

Besides being large in a traditional sense, Information Age is highly interactive. It has 56 personal computers, 4 workstations, 2 minicomputers, 44 video disk players playing 2 1/2 hours of audio and video material, 2 high speed printers, 3 video projectors, 4 large projection monitors, 20 standard video monitors, a high definition television, a 12 screen video wall and an automated sound sampling and regulating system. An exhibition of this size and scope would have been impossible without extensive support and help from private industry. The Smithsonian received over $4 million in cash donations and the equivalent of over $5 million in donations of computer hardware, software, and services.

We wanted the exhibition to be what it is - the most interactive exhibition the Smithsonian has ever done. But we did not want the interactivity to dominate the visitors' experience. We wanted it to be supplemental to the basic Smithsonian experience of seeing original artifacts in historical context. Our goal was to use interactives to provide fuller context and more experiences related to understanding our subject.

Most of the interactive components are connected by two electronic networks. An IBM token ring links the personal computers. These PCs control video disk players and other peripherals, the theater systems, the exhibit database, and other components. Connected to the token ring is an Ethernet backbone that handles the exhibition monitoring system. The network requires 23 distinct software programs. It serves three major functions. First, it enhances the visitor's experience. When visitors come into the exhibition, they can "log in" by scanning an "interactive brochure" on an NCR bar code scanner. This is the same type scanner used in many grocery stores or other point-of-sale terminals. The brochure is a printed guide to the exhibit that has a bar code on the back. Each bar code is different, so each visitor is tracked individually. At 8 different locations visitors can scan their bar codes and then use a computer-based interactive to learn about a subject related to the surrounding displays. At the end of the show, they can get a customized printout about their experience. The network collects and passes along the data necessary to build the printouts.

Secondly, the network helps keep track of the operational status of the computer stations, video interactives, theaters, and other electronic components in the show. Network software alerts operators in the control room immediately when a station goes down. The show relies on a customized version of the same software that EDS Corporation, one of our corporate sponsors, uses to monitor banking, insurance, and other networks throughout the world. This monitoring system has helped us keep our up-time on systems at around 99%.

Finally, the network helps us learn about visitor behavior. Using the individualized brochures, it monitors and counts visitor interactions. We do not track visitors by name, and using the interactives is completely voluntary. Although our monitoring system does not give us rigorous statistical samples, it does provide us a much fuller and richer understanding of visitor behavior with interactives than we have ever had before. We are monitoring hundreds of thousands of visitor interactions unobtrusively and at little cost above regular operating expenses.

Visitor Behavior

Information Age opened on May 9, 1990. From data on interactive brochure usage, we estimate that we have had around 1.5 million visitors in the first year. Visitors can scan the bar code at a total of 19 different stations. We know that 426,000 different brochure users scanned at one or more of the bar code readers. Periodic studies tell us that between 1/3 and 1/4 of our visitors choose to use the brochures at some point in the exhibit. Often, for example, only one member of a family group will use a brochure. We multiply users by 3.5 to get our total visitation estimates. Rough as this metric is, it is much better than that for any other exhibition in the museum.

The busiest day we had during the first year was July 4, 1990, when 6,185 people used brochures, for a total visitation of perhaps 21,647. Neither of us was in the museum that day, but we guess that we actually had only about half that number. At that time, we were using a stanchion system to encourage brochure use, so it was higher than average during the year. Whatever the actual count, reports were of wall to wall people, and the exhibit had to be closed at certain points during the day because it was too crowded.

On an average day, around 1,100 people use brochures, for a visitation of perhaps 3,850 or some 500 per hour. We designed the exhibit for a maximum of about 400 per hour. We have a limited estimate of time people spend in the exhibit. The 30% who use their interactive brochures at both the beginning and near the end of the show spend at least 35.34 minutes in the exhibit. We say at least because the last, most interactive section of the exhibition comes after the point where people "log out" of the system. Since this section has 15 interactive stations and since most of them are sit-down experiences, people frequently spend much time there.

We don't know how representative the 35 minutes is for all visitors, but we believe it supports our general impression that visitors tend to spend much more than the average 20 minutes per exhibit in Information Age. The tours we give take about an hour, and we know from random interview data that some people spend many hours in the exhibition. Obviously, many others only breeze through. But if we have increased visitation to an average 30 minutes per visit, we have made a major difference in visitor behavior.

We have two basic categories of interactive displays in the exhibit: video selectors, at which visitors can choose among 4 video clips related to surrounding displays or related topics, and computer interactives, in which visitors engaged in programmed multi-media experiences shaped by their own input.

Video Selectors

The traditional use of film or video is in continuously looping programs. We use this format in two sit-down theaters in the exhibition, one mid-way through showing a 6 minute program, and the other at the end of the exhibition. The latter is a 12 screen video wall production that summarizes the themes of the exhibition. We also have 15 "environmental" video or audio loops in other sections of the exhibition. We won't be discussing them further here, as we do not measure visitor reactions to them.

Video selectors, in contrast to loops, give visitors the opportunity to choose what they want to see. We have six video selectors in the exhibit, each with 4 selections, for a total of 24 programs in all. Visitors make a selection by touching the image of a frame from the video clip. They can restart or change their choice at any time. They also can choose to turn off subtitling. On average, video clips run around 2 minutes. The longest clip is 3 minutes and 13 seconds; the shortest is 47 seconds.

In the first year, we recorded 437,244 playings of video selections. We say "playings" instead of "viewings," because normally more than one person is watching a selection at any time. To convert "playings" to an estimate of "viewings," we multiply by 3. Thus we had approximately 1,530,354 "viewings" in the first year. This means that on average, each visitor to the exhibition watched between one and two video segments in the exhibition.

Popularity

The most popular video segment in the exhibition was played 36,622 times, for 109,866 viewings; the least popular 8,048 times, for 24,144 viewings. Interestingly, the most and least popular items were on the same station. The other two selections on this station were also generally lower than those of other stations. This probably shows that visitors were likely to look at only one selection on the station, and thus the most popular item drew attention away from the other possibilities there.

The most popular item was a humorous cartoon giving visions of how new technology would change American society in the post- World War II era. The popularity clearly depends on the subject, style, location and format of this piece, not the novelty of the technology. By this time, visitors have had the opportunity to use 3 other video selectors and four interactive computer stations. This statistic indicates the drawing power of both humor and the cartoon format. Incidentally, the two other comedy clips among the video selections are also highly popular. One, with 31,370 playings, includes a section of Charlie Chaplin's Modern Times. The other, with 30,004 playings, is a clip about Abbott and Costello using the telephone.

A second, less complete group of statistics gives us an indication of what percentage of the videos people are watching by telling us when they switch to another program. In this case, we can only sample days. We do not have complete year-long statistics. On a recent day, we found that people on average were only watching 26% of the most popular video before switching. Of course, we have no way of measuring when people are walking away and just letting programs run to the end. The average for all the videos was 50% before switching. The 26% was the lowest for any video. People watched 51% of the second most popular clip, and 41% of the third most popular. We don't have statistics on the spread of viewing behavior, so we don't know if behavior clusters around the average viewing, if we have many quick samplers and a balance of people who watch the whole program, or if we have some other distribution. Unquestionably, however, browsing of some sort is the predominant behavior of people who use the video selectors.

Content observations

The video selections include clips with both social content and technical content. We were interested in what the difference would be in visitor popularity. There is no definite pattern. For example, a "technical" video showing how Morse's telegraph and Bell's telephone work logged 14,420 selections; one on the operations of the ENIAC computer logged 30,908. The latter was the third most popular video in the show last year. A "social" video on scientific management got 26,809 selections - a number between the previous two. On one video selector, people were more interested in the technical stories of the development of the mouse, the microchip, and the PC than they were in the people who worked on the assembly lines to build computers. When we were developing the show, we believed we should have a mix of technical and social sections. Our data seems to show that this assumption was correct.

Computer Interactives

Information Age has 12 interactive computer stations on the network. It has another 15 that are stand-alone interactive stations, all in the "interactive gallery" section of the show that concludes the exhibition. There are also two printers at the beginning of the Interactive Gallery where visitors can print a record of their activities. Ten of the 12 networked stations in the body of the show are IBM InfoWindows with touch screen interfaces. These systems provide multi-media presentations in a form that is responsive to visitor input. The other two stations are operated by an electronic pen that visitors can use to "write" and record their comments on the face of a computer screen.

The 10 InfoWindows play 7 different programs. The first three programs in the show play on two stations each. This duplication near the beginning of the show helps prevent lines. We assumed that by the end of the show, demand for stations would spread out so that lines would be less of a problem. In addition we provided more alternative stations at the end. With the exception of very busy days, our assumption has proved true. We can have lines on busy days, but the number and variety of experiences available in Information Age keeps them from being a significant problem.

According to our statistics, visitors have used the interactive stations 931,397 times. Again, as with the videos, several visitors will frequently watch the interactive when one person is using it. We estimate that the appropriate multiplier to convert uses to "viewings" in this case is much lower: about 1.5 viewings per use. Using that multiple, the interactives have been viewed 1,397,096 times. Because our statistics do not track individual visitor behavior, we cannot compute behavior distributions. We can only say that on average, visitors are using around one computer interactive in the show. What this probably means is that many visitors are not using any at all, while other visitors tend to use 2-3. We suspect that only a limited percentage are using more than three. Of course, with the numbers of people we handle, even a small percentage equates to thousands of people.

Fifty-six per cent of the uses of interactive stations are initiated by bar codes. This means that the interactive brochures are popular with people who choose to do interactives, but that many people also choose not to use brochures. Obviously giving visitors a choice provides an appropriate option.

Popularity

The most popular program in the exhibition relates to code breaking. It runs on two stations. Visitors played it 314,564 times in the first year, so it had approximately 471,846 viewings. With the program, visitors can encipher their name using a simulation of the German ENIGMA cyphering machine. Then they "decode" it by remembering the machine rotor settings they used to encode it. Finally, they can see actual German messages that were intercepted and decrypted during World War II. These stations are not the first in the show, so their popularity does not depend on their novelty.

We believe that the subject attracts visitors, and so does the fact they can encode their own names. Making programs personally relevant to visitors clearly increases their popularity.

The least popular station is one of three grouped near the end. At this station, visitors can simulate being a news producer. This station had 15,697 uses during the first year, or approximately 23,545 viewings. We think several factors contributed to the somewhat low usage: the 5 minute length of the program, the several alternatives nearby, and the limited degree of visitor activity in the program. Our statistics are useful in confirming that this station needs modification to attract the attention that other stations are receiving.

Visitor statistics

The first pair of stations in the exhibition present a program related to the 1890 census. This program is the second most popular in the exhibition, with 314,564 uses, or approximately 471,846 viewings. When using the program, visitors give several bits of information about themselves: their sex, age category, and where they live. Then they learn what their life might have been like according to 1890 census data. Finally they can see a video of what processing 1890 census data with an original Hollerith "punched card" machine looked like. An original Hollerith machine is on display in the adjacent case.

In the first year, 99,230 users scanned their bar codes at the census stations, and we have some interesting detailed statistics about them. Fifty-one percent told us they were women, and 49% told us they were men. We had expected a larger difference.. We worked hard to make Information Age as attractive to females as males, and this statistic is at least one definite indication that we are meeting our objective.

The users of the census stations were 40% from the Northeast, 15% from the Midwest, 14% from the Southeast, 13% from the West, 8% from the Southwest, 7% from foreign countries, and 3% from Alaska and Hawaii. This distribution reflects the fact that we are truly a National museum, with more people coming from outside our region than from within it. We also have a large international visitation. For example, if we extrapolate these figures to cover total visitation, we can estimate our foreign visitation in the show in the first year at around 105,000 people.

The age distribution of station users is also interesting: 28% are under 15, 25% between 15 and 25, 35% are between 25 and 44, 9% between 45 and 65, and 3% over 65. We think that the 12% over 45 is under-representative of this age group in our exhibition visitation, and most likely reflects the reluctance of this group to use interactive devices. The 53% under 25 likewise probably over-represents this age group among our total visitation, and indicates the expected interest of these age groups in interactive technology. The fact that the majority user group is between 25 and 44, however, shows that this group is also interested in and comfortable with interactives. Probably this has much to do with the pervasiveness of computer technology in the office and society generally, and also to the simplicity of the touch screen technology and the program we are using.

Polling Station Statistics

Some other interesting statistics in the exhibition come from a station where visitors express opinions about television. Forty-two percent say TV impairs education, while 58% don't think so. The "experts" in our background research were closer to 50-50. Among our visitors, 72% found prime time TV programs more interesting than coverage of presidential political debates in 1988.

Financial Stations Statistics

In the last section of the show are three interactive stations where visitors can explore different applications of computer networks. One, which we discussed briefly above, relates to producing a news documentary. The second allows visitors to listen in on an emergency 911 call and see the charts and maps that provide emergency information. The third allows visitors to become international currency traders. We give them $10 million and give them several opportunities to make money by moving their funds to other currencies in response to changing news headlines. This third station is the most inaccessible of the three, but it is also the most popular, with 34,502 uses. Interestingly, several members of our planning team believed this station would be too complicated for visitors to enjoy. The moral of our statistics: never underestimate the drawing power of money.

Comment Station Statistics

At the end of the exhibition, visitors can make comments on the exhibition. Using an "electronic pen" that records their gestures on a computer screen, they can indicate whether they liked or did not like 10 different areas of the exhibition. On average, visitors said they liked 75% of the areas. The most popular area, the section on television rated an 82% positive rating. The least popular on the ENIAC rated a 66% positive rating. We frankly don't trust these reactions too much. We suspect that visitors are as interested in the novelty of the technology as they are with making a definite vote on likes or dislikes. They may be making some positive and some negative checks just to try the device out. Still, it gives us a relative measure of reactions to different sections of the exhibition.

Conclusions

At the Smithsonian, we would like to believe that visitors are really scholars and are as interested in the details of our subjects as we are. They aren't. The behavioral measurements we are collecting with our network are helping us develop a more realistic pictures of visitor behavior. To a large extent, they are confirming patterns we had already detected in other ways.

We know that most visitors come to the museum in groups, not alone. They are there primarily to have a "successful outing." They come to do something that is interesting and fun. They are happy to learn, but they are generally not engaging in purposeful learning behavior directed toward new conceptual understanding.

A good general description for visitor behavior is "educational browsing." Like someone scanning a book or looking around in a section of a store that interests them, visitors tend to browse an exhibit space. Since they are there primarily to explore and not to get specific new information, they will frequently stop their exploration before they complete an experience. They are particularly likely to do this if they are having trouble. They want to be challenged, but do not want to have to learn many new techniques or overcome significant obstacles.

After going through an exhibit, visitors are much more likely to give a coherent answer to the questions "What did you see in the exhibit?" and "What did you do in the exhibit?" than they are to "What was it all about?" "What are the main themes and message?" or "What did you learn?" Most visitors are collecting impressions and experiences that will "make sense" later in conjunction with other experiences and activities in their lives. Unless prompted, they do not usually think through and synthesize what they have just done as an independent learning experience.

As our statistics clearly show, interactive devices do not change this browsing behavior much. They only broaden and increase it. They provide new forms of presentation and greater choice. They also have a very useful ability to personalize experiences, by presenting information or experiences customized to the characteristics of the individual visitor.

Interactivity and traditional exhibitry

Displaying original artifacts and images and explaining their cultural significance is the main mission of the National Museum of American History. Our goal in Information Age was to use interactive elements to supplement, not replace traditional exhibition techniques. Although our data is not complete, our statistics show that we are accomplishing this objective. Visitors are clearly still spending most of their time looking at the traditional displays in the exhibition. The availability of interactives does not diminish interest in seeing artifacts or period settings. In Information Age at least, the time visitors spend with interactives seems to increase the normal amount of time they would have spent in the gallery if the interactives were not present.

Item-specific and contextual explanations

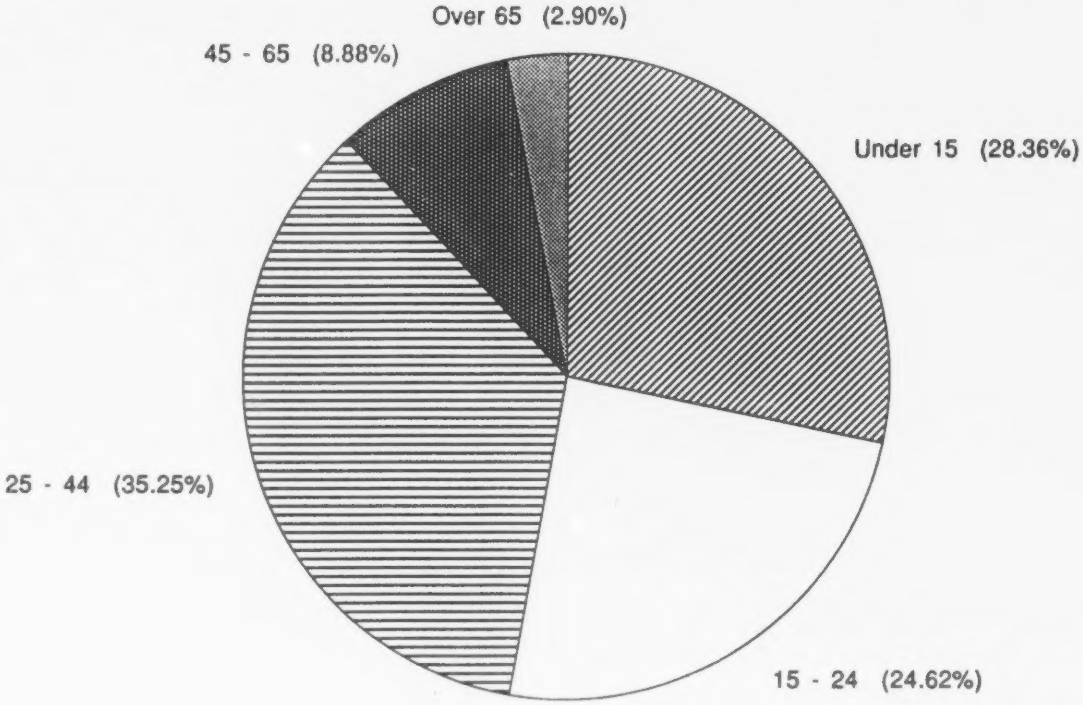
We have a running debate at the Museum of American History over the balance between item-specific presentation and contextual presentation. In the area of science and technology, this usually becomes a debate over presenting technical explanations of what the devices are and how they work or information related to their social context and use. Traditionally, of course, most of our presentation was item specific, focusing on "What is it? How did it function? Who made it and why?"

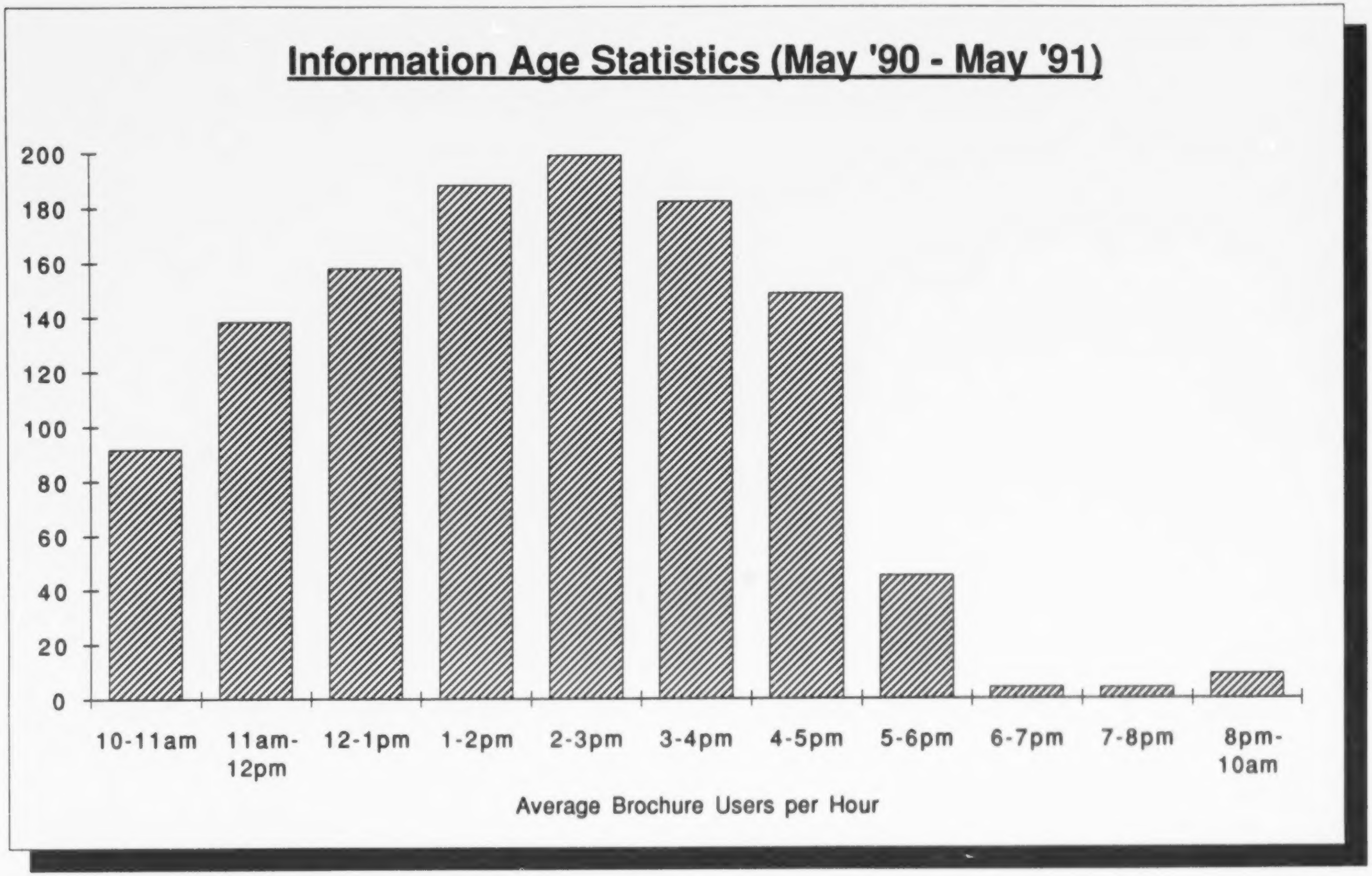
The trend in recent years has been to focus more on social context. Information Age worked to present a balance. Our statistics, especially from the use of video selectors, shows that visitors want that balance. Material related to social context interests them - particularly if it is humorous. But they also retain a strong interest in knowing what the artifacts are, even when they are highly technical items like computers or chips. We would like to know more about whether individual visitors inherently seek a balance in satisfying their individual interests, or whether the balance is desirable to satisfy different sorts of people. Either way, maintaining a balance in the exhibition is an important goal.

Networks in exhibits

Electronic information networks are an interesting new tool for museum exhibits. They can monitor and regulate system operations, measure visitor activities, and enhance visitor experiences by maintaining a personalized record of visitor activity. Of course there is a significant cost for implementing and running an exhibition network. It requires greater complexity and cost in exhibit development and more sophisticated exhibit operations and maintenance. Based on our first experience, however, we believe that information networks hold much promise for exhibitions in the future.

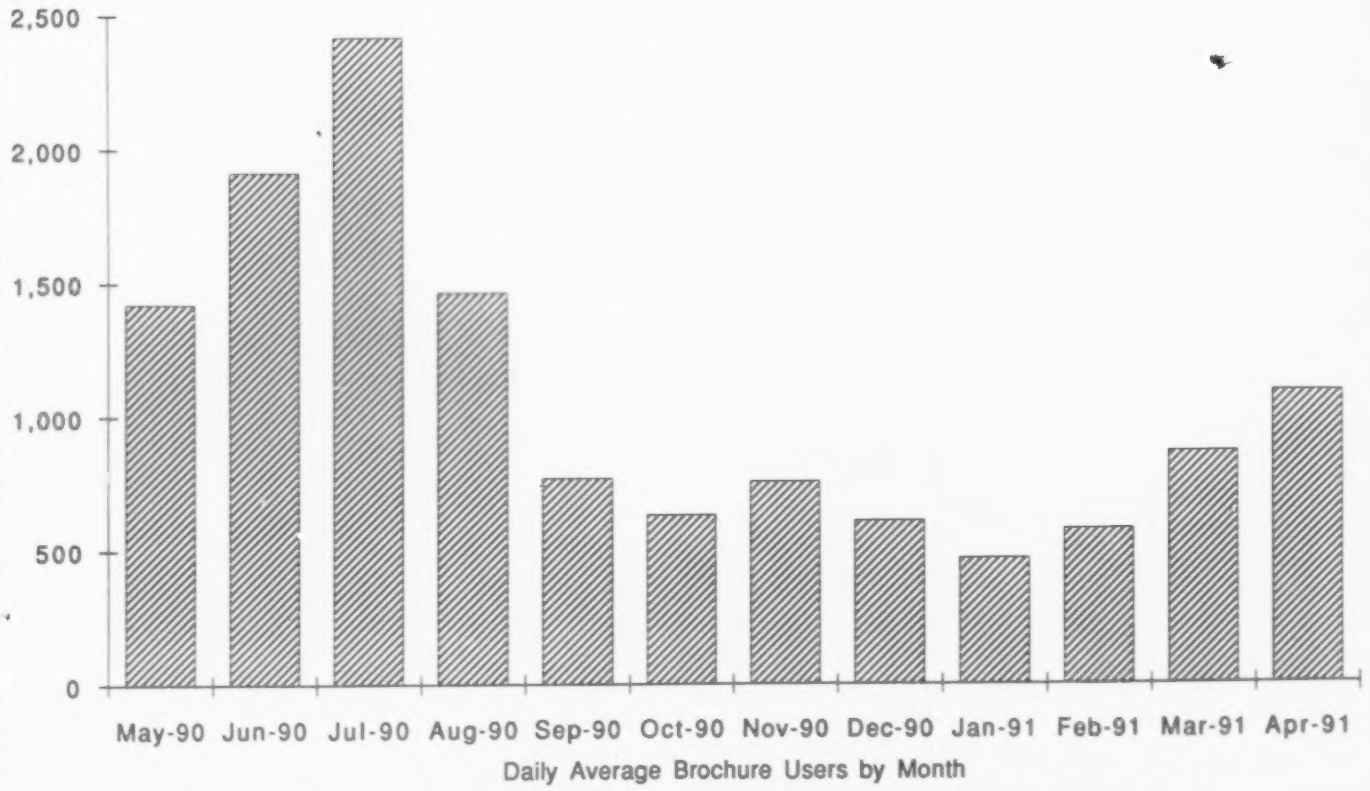
Information Age Statistics (May '90 - May '91)





Information Age Statistics (May '90 - May '91)

Information Age Statistics (May '90 - May '91)



Evaluation of Hypermedia and Interactivity in the Museum:

A Constructivist Approach to Instructional Design

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Contemporary educational communications and technology have brought new ways for presentation of museum content. Advances in telecommunications, computers, videography and printing are revolutionizing the grounds on which people encounter art, science, and culture. This technological change is causing scientists and educators to re-think the formats for their material in our museums and, eventually, in our homes. Sensible perspectives on evaluation are needed to guide the use of the old content in the new venues. One convenient source for a checklist of principles for evaluation of interactive exhibits is the Responsive Environments Program developed by Dr. Omar K. Moore. This paradigm has been applied educationally to many technological innovations as they have come forth in the past four decades. The principles are fourfold: Perspectives, Productivity, Personalization and Autotelicity. Exhibit designers are encouraged to consider the playforms or "folk models" which the visitor would assume during the interaction with the hypermedia. While the environment does promote free exploration and creative application, there is expert feedback throughout the experience.

Museums have become leading players in the introduction of educational technology to the world. Because program content is so crucial to the success of the new electronic dreams, museums will be increasingly important partners in the development of multimedia software. Furthermore, there is a steady parade of new and innovative projects in museums applying a wide variety of interactive, multimedia formats to the presentation of traditional material. The technological change provides the museum scientists and educators with a window of opportunity to examine the "what" as well as the "how" of their exhibits. Museums are not mere storehouses or showcases for old things. They are places for instruction, and their visitors will be learning something for better or for worse. Teaching is an inescapable part of exhibition regardless of the medium. This paper will present a brief update on the new technological options for the museum designer and a theoretical perspective for the design and evaluation of hypermedia and interactivity in museum education.

The Design of the Electronic Museum Educational Technology

In our time quantum leaps are made regularly in telecommunications, computing, video, audio, and print. Distance education is practiced in more settings (Saba, 1989 and Moore, 1990). The price of computer memory storage continues to decrease even as the capacity of such devices increases. With the increase in speed and memory comes the ability to represent complex graphics to the point of photographic realism. New software from Apple Computer Company, QuickTime, allows the developer to paste video clips into a digital file. Thus, a dynamic sequence can be called up as easily as a word processing text file. Resolution and speed of the images is becoming increasingly natural because of the compression algorithms. The fidelity of auditory resolution, as well, has become expected due to the huge success of the affordable players for audio compact discs. Finally, print materials of the very highest quality can be generated on the desktop.

These new tools are impressive in their own right, but as designers it must be remembered that the tool is just a means to an end. The substantive content and instructional design of a presentation remain the crucial factors. A noted jazz musician once said, " You can only play as far as your concept" (Miles Davis). Great video and stereo enhance good content and design but they cannot cover for bad ideas. Therefore, a knowledge of formal instructional design is important for the museum educator who would implement hypermedia and interactivity.

Educational Design

Through the history of instructional design there have been three dominant psychological views as theoretical bases: behaviorist, cognitivist, and constructivist. These paradigms have guided the work of instructional designers over the past 50 years regardless of media. "You can only play as far as your concept." The view of the learner and how he learns are the ultimate guidelines for the one who constructs a museum exhibit. Seeing the learner through a behaviorist lense is to look for those stimuli which will lead to certain desired responses (Skinner, 1954). What do you want your visitors to do upon entrance and exit from your institution? What sorts of things are discriminative cues for these desired responses? What rewards will be effective to maintain the attention and targetted behavior of the participant. This empiritcal method relys heavily on planning specific responses and investigating the experiences that reinforce the goals of the exhibit.

The cognitivist proceeds in a somewhat similar way (Gagne, 1985). There is the same commitment to a scientific, mechanistic view of man. The big difference is the attention to the internal ideation of the participant. Based on the information-processing model, i.e. man as computer, this paradigm accounts for the individual mental processes of interpretation which go on as one interacts with the museum exhibit.

A more subjectivist approach to instructional design is based on the Constructivist psychological base. Learning is more a process of constructing knowledge than merely receiving facts which produce pre-selected responses (Behaviorist) or are processed with pre-set algorithms (Cognitivist). Thus, the Constructivist model has the theoretical horsepower to conceptually cover creativity on the part of the user. Recommendation coming from Constructivism emphasize setting up an optimal environment rather than dictating responses or thinking. Please note that there are times when behavioral and cognitive processes should be dictated. But it is vital that the museum visitor be engaged creatively. Thus, Constructivism should be the instructional theory of choice for museum exhibits.

Changes in Museum Presentations

The case for the Constructivist approach to development and evaluation is even stronger in light of technological progress. Contemporary computer workstations are able to mix and match a number of media on the same platform. Whether slide or film projectors, multiple audio tracks, or innovative input devices, the digital revolution is creating a common format for the interaction of variety of forms and colors.

In recent times electronic communications has been a matter of delivering an active message to a passive recipient. In the past decade there has been a great emphasis on the interaction between the receiver and the medium. For example, interactive videodisc has been the most acclaimed new technology in museum and education. With the wide choice of media and the interactive capabilities of the digital computer, creative production has become a standard expectation--as opposed to the passive reception of information.

The image of man presented in S-R behaviorism and information-processing cognitivism is mechanistic--discrete input and specific output by design. On the other hand, constructivist design considers how the learnier makes innovative use of the variety of media to produce some intelligent and aesthetic product. Rather than preselected response, the surprise of creativity is anticipated. Thus, the museum experience should lead to an intellectual or material product which is the result of a productive enterprise on the part of the visitor. No more snake--that trail of elementary students shuffling through the day at the museum. the goal is nothing less than to move the museum from a dusty archive to a shiny new paradigm of modern communcations with interesting content.

How can one present interesting, engaging challenges in the contemporary museum? Design of information-rich, sensory-exciting exhibits requires a sufficiently sophisticated model of instruction. Such guidelines can be found for instructional design in the work of social psychologist Omar Moore. (For standards of mechanical design of exhibits see the work of Donald Norman (1988), a leading cognitive scientist with a Constructivist viewpoint.)

Principles for the Responsive Environment in the Museum

One of the best exemplars of the Constructivist view is the work of Omar Khayyam Moore and the Responsive Environments Program (1969, 1980). This ongoing R&D effort has addressed educational technology according to mechanical, cultural, theoretical, and logical concerns. It has characteristically invented new machines, educational programs, social science models, and mathematical representations for human activity. The Responsive

Environments Program has been both eminently practical and philosophical. The principles developed over the forty-year research project are apt direction for exhibits with hypermedia and interactivity. The following four principles are standards by which digital museum projects may be evaluated.

Perspectives

Moore and his colleagues use four basic principles to guide instructional design: Perspectives, Productivity, Personalization, and Autotelicity. In any educational situation an effort is made to place the participant in four different control perspectives. (1) If a learner is in full control of the operation of the exhibit then he has the agent perspective. This is that of the scientist, a puzzle-solver. (2) If there is no control then he is a patient. Much like the gambler playing a game of chance, significant elements are beyond regulation of the operator. (3) If a visitor to the exhibit can interact with another person in the course of working the presentation, then he is a reciprocator. The challenge of this social situation is to solve problems as one takes the other participant into account with every move in a strategic contest. (4) If the student is to make normative judgements, aesthetic or ethical, then he has the perspective of the referee. There is a values-dimension to any responsive environment. Interestingly, this is the one perspective for which Moore could not find a mathematical model.

In the course of his research on the logic and social psychology of problem-solving, Moore noticed the importance of games. Having read Georg Simmel on games and play-forms, i.e. roles in play as preparation for roles in society, he knew there was great cultural significance to all the fun (Moore, 1952, 1990). This led to an exploration of the cross-cultural files at the Yale University library in search of commonalities in games aroung the world. Moore found these four general types of playful activities which serve as models for instructional design: the puzzle, the game of chance, the game of strategy, and the arts. The Perspectives principle is a useful tool for thinking about how to present the subject with a variety of operational and social contexts. There will be individual differences in tendency to enjoy one or more of these social structures, but the ideal learning situation will be to give an opportunity in each of the perspectives. Multiple perspectives lead to more enjoyable and greater enrichment, i.e. productive learning. The museum exhibitor can use these formats as a checklist for the instructional design of the presentation.

Productivity

The second principle is Productivity. When one experiences an exhibit, one should learn information or procedures which help in future situations. The insights and processes that are gained in a museum exhibit should help to understand other parts of that exhibit, other parts of the museum or elsewhere in the world. Learning a concept or fact should have relevance to later understanding. Again, note that this is far from a passive view of the museum visitor--there is an expectation of enrichment.

Hypermedia implies movement within an environment abounding in important information. If hypermedia is a mere shuttling of sights and sounds from one location to another, then it becomes a superficial chaos. If, however, one encounter in the exhibit leads to progress in competence or understanding, then there is productivity. The participant is enriched as well as entertained.

Personalization

Another set of heuristic guidelines within the paradigm developed by the Responsive Environments group is summed up as Personalization. How do you engage the observer? It can be done via both responsiveness and reflexivity.

Whether training sailors to learn symbolic logic, retarded children how to read or treating museum visitors to a great afternoon, a personalized environment will include: permission for exploration,

- presentation of immediate feedback,
- allowance for self-pacing,
- promotion of discovery, and
- provision for interconnectedness.

The following example shows the responsive features of the personalization principle. A prototype of this illustration can be found on Verbum Interactive: CD-ROM Multimedia Magazine (Dayton, 1991). In a science museum an exhibit might be done on a space theme, e.g. Space Art with Michael Carroll. Great artwork, graphics, and photographs are arranged in a responsive environment on a CD-Rom driven by a computer with ample memory and speed. The user can choose which planet to visit. A smart design gives help when needed and makes navigation easy. In a comfortable position, the visitor may pause to ponder a landscape from Mars or hurriedly go from Pluto to deep space. In the course of visits to planets new insights about landforms and strange physical properties will be presented via digital audio by the artist-scientist-teacher himself, Michael Carroll. These discoveries will be thematic and often related to other facts about space or procedures employed in space travel. Hypermedia and interactivity on a Star Trek leit motif!

Along the journey another goal would be to allow the user to see himself as a space traveler. He could get a sense for the look and feel of being an astronaut. This is the second major component of the Personalization principle: reflexivity. Human beings can conceptualize actions, thoughts, and feelings with objectivity. Self-perception is crucial for evaluation of intellectual or motor progress. Furthermore, the emphasis on reflexivity guarantees relevance. The exhibit is more than a series of abstractions about the space program. What if I was really exploring the solar system right now?

Autotelicity

The museum is the perfect place to develop a responsive environment. The final principle has to do with the choice of a person to participate in our exhibit. Optimal learning requires motivation and choice on the part of the user. Because museums are not compulsory, like schools, they tend to allow autotelic decisions regarding engagement in available activities. Not all constraints are removed from the museum visitor, there are always ethical boundaries, but a large measure of freedom of choice may be given. When such choice is provided, motivation and enjoyment increase greatly. This sort of motivational set is required to participate with an interactive exhibit--you cant just sit there!

The principles of the responsive environment program--Perspectives, Productivity, Personalization, and Autotelicity--are ideal for hypermedia and interactivity. Based on a Constructivist model, they guide the development of museum exhibits which lead to engagement and enjoyment. Given true and beautiful content, digital equipment will be the tool to deliver a new generation of worthwhile museum experiences. As Bill Atkinson remarked in a recent interview in which he was critical of applications of computers for children as an exclusive answer to the problems of education:

> If you're looking at multimdedia as a way to dress up information so it can be more entertaining, thats what multimedia does. And this as a solution to the burning problem (of education) is analogous to high-definition television as a solution to lack of content in television programming. The problem with leaning doesnt have to do with information delivery -- it has to with motivation. And multimedia, even though theres nothing wrong with it -- its great, its wonderful, just like sharper television is wonderful -- draws focus away fromn the real problem. People say, well, we used multimedia to beef up our schools. I think theyre kidding themselves. What I hear about multimedia now sounds to me like people going around in the 70s saying bitmap displays were going to solve all their problems with computers. (Dayton, 1991, p. 2, Look and Feel feature).

We return to Moores fourth folk-model, the referee perspective. Normative judgements about the content and style of a school curriculum or a museum exhibit are an inescapable part of evaluation, regardless of the medium. Judgment of the aesthetic and ethical dimensions of multimedia in the museum will be as important as evaluation of the emotional impact on the participants and the effectiveness of information delivery. It is time to consider carefully the standards by which content and design are critically esteemed.

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Reliability of Interactive Computer Exhibits
or, Why Doesn't This @#!!#& Thing Work?

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It is important to know how to analyze the components that make up an interactive system. The components that suffer the worst abuse are the "visitor input devices." The safest approach is to use parts from devices that are known to stand up to unsupervised public abuse. Unfortunately, incorporating these devices into exhibits is not always easy. Standard mice, keyboards, and trackballs can be as troublesome as they are easy to use. Touchscreens are excellent interfaces for many exhibits. There are a few types of touchscreen, each with advantages and disadvantages. Proper program design and attention to overall system reliability can save touchscreens much abuse.

Broken software can be harder to resolve than broken hardware. You can call on a range of people to write your software, each with advantages and disadvantages. Off-the-shelf packages may not perform as advertised, and may exhibit bugs which will never be repaired. There are strategies which avoid most of these problems.

Each device has environmental constraints (temperature, humidity, dust control, etc.) which must be taken into account very early in the planning process, as the constraints effect fabrication, electrical work, air conditioning, and the general use of space. Locating all the equipment at the exhibit kiosk has advantages and disadvantages, as does placing some equipment in a remote control room.

No matter how reliable a system is, it may go down at some point. If no one has the job of dealing with problems (and adequate time available), the system will probably stay down for a very long time. The larger an investment a museum makes in interactive exhibits, the more important this issue becomes. Due to the pace of change, a museum may find that a few years after installing a system, it can no longer purchase a replacement for a system element. The system can be designed to minimize this problem.

A frustrating visitor interface may leave visitors thinking that the program is "broken." Slow response time may encourage more aggressive use of the input device. Constantly accessing one sector of a floppy disk can cause problems. In short, poor program design can contribute to downtime. Though there are a few guidelines, the best way to develop a good design is to involve the right parties in the design process, and to conduct formative evaluations.

Introduction

"This thing is broken." Usually a plaintive cry uttered by a child telling you that one of your more expensive (per square foot) exhibits is, for the moment, worse than empty floor space. Trouble. How often you have trouble and what happens after it starts are important determinants of the worth of any exhibit. Interactive computer exhibits are especially distressing for many museums. Creating and maintaining these exhibits is a technical specialty. Yet it is possible for any museum to anticipate and manage the inherent risks. After years of dealing with a wide variety of museums, I have met some bogeymen that await you.

"Interactive computer exhibits" is a very general term, ranging from a touch screen driven videodisc presentation to an station which records pulse, flexibility, and grip strength for a larger health profile. Because the exhibits are interactive, they are subject to the same abuse as your flip-panels, water screws, puzzles, and other interactive mechanical exhibits. Because they involve computers, they may even break when no one is using them.

Reliability of Individual Components

The most obvious contributor to a system's reliability is the reliability of each of its components. One broken element usually means that the entire exhibit is down. I could list my current picks and pans for hardware. Products, however, have short life cycles. The unique minds of exhibit designers call for using ever newer devices. It is better to know what to look for rather than have a list of good products.

The components that suffer the worst abuse are the "visitor input devices." Most museum professionals don't need to be told to be wary of buttons, joysticks, and the like. Standard mice, keyboards, and trackballs found in computer magazines usually come with software toolkits. Because these devices are easy to integrate into a range of off-the-shelf software (e.g., Hypercard), they are seductive.

A more prudent approach is to use parts from devices that are known to stand up to unsupervised public abuse (parts from arcade games, vending machines, automated teller machines, payphones, etc.). These devices can be found in catalogs and magazines that cater to the appropriate trades. Unfortunately, incorporating these robust industrial devices into exhibits takes more effort than using consumer oriented items. It takes quite a bit of research to find the parts and learn what they really do. You will probably have to write your own software drivers as well.

Joysticks provide an excellent example. We have seen good consumer quality joysticks break in under a month of use. Arcade quality joysticks are known for spraining wrists without breaking ("PAC Man Wrist" made it into the New England Journal of Medicine). However, a consumer joystick will plug into a "game port," a standard item on many computers. The consumer item will also work with a wide range of software. The arcade joystick works a bit differently from the consumer version. To make it robust, the designers simplified it. A consumer joystick will send out numbers that represent a range of x,y positions to the computer. Such sticks can be used, for instance, to guide a cursor across a screen with a fair amount of control. The arcade sticks simply trigger one of four (or eight in a slightly fancier version) switches as they are pulled or pushed. The simplicity of the design allows for very sturdy construction at a cost that is lower than the cost of the consumer item. The problem, however, is that the exhibit designer must take into account the different characteristics when planning a visitor interface. The PAC Man arcade game is an example of a good design for an arcade stick. The player guides a PAC Man around a maze by pushing the stick in one of four directions. Using consumer software as a starting point for program design may lead the designer down an unworkable path.

There are very high quality joysticks which behave like consumer joysticks. They are made for the military, and carry price tags well over one thousand dollars a piece (versus well under one hundred for the arcade style).

Touchscreens are excellent interfaces for many exhibits. Out of over five hundred touchscreen systems that we have put in the field, we have seen very few problems other than gradual wear. Though a touchscreen may be more expensive than buttons or trackballs, they require no more fabrication expense than would a monitor alone.

Touchscreens come in a few flavors, and each has its strong and weak points. Each also has its advocates. NETG has favored the "resistive" style of screen. The touch sensor is a plastic and glass sandwich that is curved to fit the shape of the monitor tube. By taking a standard monitor, removing the tube, taping a curved touch panel to it, and reassembling the monitor, you have a touchmonitor. A drawback to these screens is that they present a plastic membrane surface to the public. We have seen some of our screens come back with scratches that disabled the screen. We have also seen a few come back with the glass backing broken, evidence that a visitor had punched or pounded the screen (perhaps in frustration, see below under "Design of the Program"). The screens also reduce the brightness of the screen somewhat, and if purchased with an anti-glare coating, fuzz the image a little (we use anti-glare coating for the obvious advantages). On the positive side, these screens offer fine resolution and quick response, allowing more software flexibility than other styles of screen.

Another common type of screen uses infra-red sensors around the edge of the screen. Visitors' fingers interrupt both a vertical and a horizontal beam as they get near the tube surface. These touchscreens offer the advantage that visitors are touching the sturdy surface of the monitor's tube. However, they have relatively low resolution, and can be defeated if visitors put a piece of gum on the edge of the monitor tube. They also provide significant parallax error, where visitors of different heights will interrupt a different beam though they are all aiming at the same point on the monitor screen. Without extensive experience, I can't offer an opinion as to their overall reliability.

There are a few other styles of screen. Before using any style of screen, it is wise to speak with other museums who have had the same type of screen installed for enough time to spot any problems.

Other common system elements include computers, expansion cards, monitors, and disc players. These can be evaluated through the experience of others, mean time between failure ratings, and inspection and testing of samples. A few general principles include: lots of moving parts can mean trouble (printers, video tape players, etc.); items that require care and feeding are tough for most museums to keep up with (e.g., printers that require ribbons, paper, and un-jamming); and industrial equipment is often more reliable than consumer equipment (but sometimes it's just more expensive).

The imagination of designers can bring in a host of other devices. It's tough to be doing "new" things with the same old reliable equipment. When possible, it's a good idea to try out individual elements, subjecting them to some abuse in a simple prototype system, before incorporating them into a system. Get kids to come in to play with your prototype. They will do things you would never imagine.

Reliability of the Software

Broken software can be harder to resolve than broken hardware. While it is easy to swap in a spare piece of hardware, if the software has a bug or doesn't perform to expectations, the choice of action is much less clear. The possible problems vary in nature depending on whether a museum is creating it own program or hiring a consultant or company to create custom software.

NETG regularly uses off-the-shelf packages as building blocks for our custom software. This practice saves our time, our customers' money, and allows us to incorporate good ideas from a wide variety of sources. We never commit to using a package for a project based on published information. Magazines and company literature often inaccurately depict the capabilities of off-the-shelf packages, embellishing without pointing out the limitations of features. Even the best magazine reviewers won't be using the software in the same way that we intend to. Many "interactive software" packages don't provide the sort of "bomb-proofing" that we feel is required in an unsupervised public access setting. After years of disappointing experiences, we have developed an intuition that allows us to read between the lines. We can anticipate some of the unpublished drawbacks. Even with our experience, however, we continue to be surprised.

We try to work with a limited set of packages. Each has its own quirks which we have learned from extensive trial, debugging, and spending countless hours on the phone with telephone support staff. In some cases the telephone support is relatively useless, leaving us to solve the problems on our own, devising "work-arounds" for observed problems.

We have efficiently incorporated off-the-shelf software into our work by amortizing the effort involved in learning each package over many projects. Museums that are creating interactive computer exhibits on their own should allow adequate time to surmount the steep learning curve before they get the first program running. Nevertheless, creating your own interactive computer programs can be rewarding and cost-effective in some cases.

One way to avoid some of these problems is to hire a consultant to work with you on your program. Most cities have many contract programmers who are experienced with some sort of interactive software. The wisdom of this approach varies widely depending on your ability to manage the consultant, the complexity of the exhibit, and the actual experience of the consultant. Most programmers are very confident of their abilities, even when they are approaching unfamiliar territory. Ask about relevant experience and check references.

One of the greatest problems with contract programmers is their transience. Will they be around in eight months when you begin to have problems or would like changes made? This is where your management of the programmer is important. Your consultant may leave town. Another programmer should be able to make sense of your consultant's work. Hold contract programmers to established standards of programming style and documentation (a topic too involved to even gloss over here). You should either get the source code from them or, if they are unwilling to provide it at a reasonable cost, arrange to have it placed in escrow where you can get at it if they move on.

I will grant that I a biased by my job. I feel that the most cost-effective approach for most museums is to hire an established interactive computer production firm. Companies like NETG have the experience to guide your project toward meeting your goals. We have design expertise that only comes from extensive practice of our craft. We will be around for years to come. We can provide the stability and support that contract programmers lack.

Interactive production companies, however, are not perfect. Our software may have bugs that are tough to sort out. It may be expensive to have us make what seem like minor changes to your program. We may be hesitant to give you our source code (allowing you to make changes), as it represents our second most valuable capital asset (after our staff). Again, check references. Make sure the company you are considering hiring is really listening to your concerns rather than trying to force one of their handy solutions down your throat. Consider whether they are committed to the exhibit business, or are just trying to fill in a slow period with your project.

I can suggest a few general principles that you can apply regardless of who creates your software. Plan. Are you going to want to update the exhibit on a regular basis, or is the information stable? Before designing specifics, establish your goals for the exhibit (it's surprising how often our customers have not clearly defined their goals). With a simple goal statement in hand you can change the program design as you learn about unforeseen constraints in the software or hardware.

The final principle of software reliability is to make the interface work for your visitors. A poor interface will be perceived as a broken program. It will invite your visitors to bang on your touchscreens, to try to wrench your joysticks out of the countertop. And it will not achieve your goals. There are many books written on the topic of what makes a good interface. Be aware that a museum has its own constraints which many of these books do not deal with. You have to keep traffic moving, so you may not want people to spend more than 3-5 minutes at a one-on-one exhibit. Visitors have no training on the interface, so it must be immediately understandable. While involved hypertext systems can be great for exploring information, they may not be the best way to achieve simple interpretive goals. Five seconds of frustration is enough to ruin an exhibit for most visitors.

One minor note: you will save yourself frustration if you ensure that you can easily get at the floppy disc drive in your exhibit's computer.

Locating the Hardware

Each device has environmental constraints (temperature, humidity, dust control, etc.). Take these constraints into account very early in the planning process, as they effect fabrication, electrical work, air conditioning, and the general use of space. You can usually learn the specific requirements of each device through product literature or from phone conversations with the manufacturer. What most of the requirements tend to boil down to, however, is that interactive computer systems work well in a range of temperatures and humidity that is comfortable to people. Remember, however, that the equipment itself is a source of heat, and tends to be located in very tight spaces. Therefore, the spaces that house the equipment must usually be ventilated or cooled.

When ventilating a cabinet, follow nature's rules by blowing the cool air in the bottom, allowing the hot air to escape out the top. Allow adequate air space around each piece of equipment, especially around any ventilation holes.

If your space is at all dusty, the dust will build up inside the equipment, and will eventually cause problems that require your attention. If your equipment is inside a cabinet, you can slow down the accumulation of dust by filtering the air that you blow in to the kiosk. By putting the fan at the air entrance rather than the air exit, you will also be blowing out air through all those tiny cracks in the cabinet. If you put the fan at the air exit, you will be sucking in filtered air through the entrance, but will also be getting dusty air through the cracks.

It is important that the equipment have a "clean" source of power. Significant power fluctuations can cause very strange intermittent problems that will force you to chase in many wrong directions. Do not use a circuit that is shared by any device that occasionally draws heavy loads of electricity, such as elevators, heaters, air conditioners, or Xerox machines.

Also take care not to locate either your equipment or any cable runs near electrical devices that are sources of electromagnetic disturbance. Watch for things like heaters, transformers, pumps, and so on. Some of our most novel sources of trouble included a Van De Graff generator and a pair of subway lines that crossed below the corner of a steel frame building. It can be very tough discover the source of these sorts of problems, and it can be equally difficult to relocate the equipment once the source is found. You should try to anticipate problems during the planning stage of a project.

Some museums have located all of an exhibit's hardware right by the public interface (monitor, leds, speakers, buttons, etc.), while others place as much as possible in a remote location such as an equipment closet. Though I have heard many justifications for the idea of locating equipment in a remote area, the only one that I give much credence to is for the sake of space. Some exhibit designs don't allow for placing bulky computers and videodisc players near the public interface.

Putting the non-interface portion of an exhibit in a remote area can cause some problems. Running lengths of cable can get expensive. You may bring in some environmental problems due to the cable run. If you need to troubleshoot a problem, you practically need two people with walkie talkies, one on the exhibit floor, the other by the remote equipment. Though you can monitor the apparent status of many exhibits from one remote room (if you have status monitors and the software will give you some sense of status), a good status reading may be deceptive. There is no way other than playing with the interface to be sure that there are no problems.

The Importance of Planning for Maintenance

From time to time we hear from a customer who has had a broken exhibit for months, and has done nothing about it. More often than not we are able to give them advice over the phone that allows them to correct a minor problem. Until the call, their visitors saw only a black screen. Though they were eager to resolve their problem for months, other pressing matters took up their time. No one person was really responsible, or the responsible person also had to write a few grant proposals, stage a temporary exhibit, and collect samples in the field.

No matter how reliable a system is, it may go down at some point. If no one has the job of dealing with problems (and adequate time available), the system will probably stay down for a very long time. The larger an investment a museum makes in interactive exhibits, the more important this issue becomes. Someone at the museum needs to own the role of dealing with the interactive computer exhibits. This "AV tech" should perform some very quick and infrequent maintenance on each system. Hardware suppliers should provide maintenance instructions.

It is tempting for museums to believe that interactive computer exhibits will simply run themselves for years without any troubles. They ask for an opinion from a producer like us, or hardware manufacturers, and they get assurances of the reliability of the equipment. We assure them that many systems do run for years without any trouble, and most problems that occur are easy to resolve. We're optimistic. Having a limited budget, and quite a bit of excitement about the various exhibits that they are in the midst of creating, the museum catches the optimism. They make no plans for maintenance of the exhibits other than assigning the AV/Tech job to some unfortunate individual who is already neck-deep in work.

In the case of a museum that is getting only one or two interactive exhibits, this approach is probably the best use of limited resources. On the other hand, when a museum is under-going a major expansion they need to plan for an increase in maintenance effort. How much depends very much on the nature of the exhibits that are included in the expansion. During the design stage, the plans inevitably are shrunk to fit the budget. This is a painful process. The temptation can be to put all the available money into the exhibits rather than setting aside some funding for ongoing maintenance. I would rather, however, see one less exhibit so that the remaining exhibits will continue to work for years to come.

Due to the pace of change, a museum may find that a few years after installing a system it can no longer purchase a replacement for a system element. The system can be designed to minimize this problem. Monitors have been a particular problem. With new monitors phased out after less than twelve months in many cases, kiosks should be designed to accommodate a potentially larger replacement monitor.

Design of the Program

A frustrating visitor interface may leave visitors thinking that the program is "broken." Slow response time may encourage more aggressive use of the input device. Constantly accessing one sector of a floppy disk can cause problems. In short, poor program design can contribute to downtime. Though there are a few guidelines, the best way to develop a good design is to involve the right parties in the design process, and to conduct formative evaluations.

Formative evaluations conducted on poor designs will give few clues toward the development of an excellent program. In order to get a design off to a good start, take advantage of the experience of people who have already created many programs. Include them on your design team at an early stage in the process.

Look at as many interactive computer exhibits as you can find. Play with the exhibit for a while, then step back and watch the visitors. As museum professionals, we tend to find even poorly presented information to be interesting. Visitors will show you problems you never expected. Take note of what you see, but resist the urge to create a set of rules or a formula. Each program sets unique demands on the designer.

Burn-in, or The Honeymoon's Over

When we are finished with the production work on an exhibit, we like to put it on a rack for a week or so to let it run. We encourage each other and our visitors to play with it. We call this "burning-in" the exhibit. After a week on the rack, we feel comfortable shipping the exhibit to the museum for installation. We often find a few subtle problems that are easy to resolve in our shop, but tough to resolve once we've installed the exhibit and gone home.

Despite our care, problems may still slip by. Conditions unique to the museum may cause new problems to crop up. Whether intended or not, the museum undergoes a second burn-in period. Though it is our responsibility to deal with the problems, the museum is responsible for noticing them and describing them to us. Unless we charge an exorbitant amount for an on-site service contract, they are also responsible for either running on-site tests under our direction or packing the equipment up to ship back to us.

This on-site burn-in period will put a greater strain on the museum's resources than will general maintenance of the exhibits. Just as a museum should allocate resources for ongoing maintenance, they should plan for a burn-in period. The time period will vary depending on the amount and complexity of the exhibits, along with the experience of the people who are producing the exhibits. The best way to get a sense of the effort involved is to speak with other museums who have installed comparable exhibits.

The Recipe

People are of of lists and commandments, so I've summarized the preceding information with the following list, or "ten commandments of reliability" if you will:

1. Begin by setting your goals for the exhibit(s). Keep them simple and clear
2. Generate a design specification. Involve an experienced interactive designer.
3. Analyze the reliability of the specified hardware elements.
4. Analyze the "user friendliness" of the design.
5. Coordinate the design with the overall space, including the enclosures for the hardware and any required conduits.
6. Choose a reliable software solution.
7. Plan for ongoing maintenance.
8. Repeat steps 2-7 until you are satisfied.
9. Produce the exhibits.
10. Allow for a "burn-in" period.

Good luck!

History Information Stations at the Oakland Museum

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The History Information Stations at The Oakland Museum are three, stand-alone, interactive touch-screen computers that combine text, graphics and motion video to provide visitors with an array of information from various points of view about the history exhibition "California: A Place, A People, A Dream." They bring together a combination of needs: the curator's commitment to labels, the collector's curiosity about objects, the multicultural community's need for a voice and recognition, the scholar's concern for historical interpretation, the visitor's desire to understand, and the youth in all of us with a chance to play. They are also the museum's first successful foray into interactive computer media, and our experiences in conceiving and creating them may be helpful to those of you about to make your first trip into computer land or to guide someone else's first trip. After a general system description, we will share our two perspectives on the development of the system from concept to final implementation.

System Description

Introduction

Each History Information Station displays a tailored attract sequence composed of exhibition images and moving video fading in and out of windows on the screen The sequence is silent but displays the message "Touch the Screen to Start." Touching anywhere on the screen brings up a 15 second video introduction presented by the curator of the exhibition, L. Thomas Frye. The first station introduces him as a museum curator whose business is history and who invites visitors to explore the past and join him on a journey through history on the History Information Stations. On the second station, the curator uses the metaphor of an oral history videotaping scene to point out that ordinary people make history and to encourage visitors seek out and listen to these stories on the History Information Stations. On the third station, the curator is surrounded by school children amazed to find a really high tech skateboard on exhibit in the museum. The curator invites visitors to look around for the evidence of their own history and to let the History Information Stations help them do that.

At the end of the video introduction, the visitor is presented with the Main Menu containing the four program elements. A voice-over introduction explains the four elements and how to choose one by touching the screen. As each element is described, a hand--produced with video graphics--appears on-screen to demonstrate how to touch the screen. Each of the four elements is described below: Open the Curator's File, Meet Californians, Explore Points of View, Solve Mysteries in History.

Open the Curator's File

A primary goal of the History Information Stations was to provide identifying and interpretive information about each of the 6000 artifacts on exhibition. The Curator's File was created to contain one and sometimes two "cards" for each object and image in the exhibition. Visitor access to the Curator's File begins with a voice-over introduction showing a graphic map of the exhibition and explaining how to choose a particular area. The visitor touches the screen to choose a section of the exhibition. The screen then shows a color slide image of each exhibit case, panel or platform in that section. The visitor then touches the screen to choose the exhibit unit of interest. A full screen view of that exhibit then allows the visitor to touch a particular object and open the curator's file. The file appears as computer generated text on a graphic overlay "card" around the margins of which the exhibition is still visible. Touch points, or "buttons," at the bottom of the screen allow the visitor to view "More Information" if a second card exists, to "See Video" if a video segment is linked to the object, to choose "Another Object," to return to the "Previous Screen," or to go back to the "Main Menu." The "More Information" and "See Video" touch-buttons do not appear on the screen unless the object is linked to a second card and/or a video interview. "Previous Screen" and "Main Menu" are always options throughout the entire system.

The Curator's File can be edited by museum staff. As objects are changed in the gallery, or as new information comes to light, the text on the "card" can be updated using our word processor and then loading the new data into the History Information Station computer. Museum staff can also add, move, delete and proof the small red squares that serve as touch-points for selecting specific objects in an exhibit. The images of the exhibition cannot be changed as these are mastered on the videodisc. However, frequently changing objects, such as textiles, have been overlaid with a computer graphic to stylize them and obscure specific details. The text is updated whenever, for example, textiles are rotated.

Meet Californians

A primary goal of the History Information Stations was to highlight the role individuals play in history. We wanted visitors to see ordinary people as a part of history-making. We invited ten Califorians whose stories, and in some case whose objects, are reflected in the exhibition to share their experiences with our visitors in videotaped interviews. In segments ranging from 17 seconds to 129 seconds, they relate personal stories that give meaning to objects on exhibit.

Visitor access to Meet Californians begins with a voice-over introduction showing the portraits of Californians with their names and brief titles. The visitor is instructed to touch the person of their choice. The screen then shows a very brief written biography of that person along with their portrait. Using the touch-button "Ask a Question" then allows the visitor to select from two to four questions. Touching a question on the screen leads directly to a video interview segment answering the question. At the end of the interview segment, the visitor is returned to the question screen. The visitor can then touch another question, choose another person, go to the previous screen, or return to the main menu.

Explore Points of View

A primary goal of the History Information Stations was to present differing interpretations of the past. We wanted to suggest to our visitors that an understanding of history is based in historical perspective and interpretation rather than a series of right and wrong answers. There are many ways to look at the past depending on one's point of view. We invited six academic historians to provide interpretive view points relating to the exhibition through videotaped interviews. Although museum staff played a very active role in working with the scholars, it was our intention to present differing points of view. To that end, scholars were given wide latitude in selecting the historical issues they felt were most important and in developing the content.

Visitor access to Explore Points of View begins with a voice-over introduction showing a list of the issues from which the visitor may select. After touching an issue, the visitor is presented with the portraits, including names and brief titles, of two to four scholars who present different points of view on the selected issue. For example, after choosing the issue "Cultures in Conflict on the Rocky Road to Statehood," the viewer is given the option of choosing Dr. J. S. Holliday, a noted expert on the California Gold Rush, speaking on "Gold and the Forty-niner's Transform California," or Prof. Frank R. LaPena, a Wintu artist and scholar, speaking on "Indians Under the Bear Flag," or Dr. Clayborne Carson, historian and editor of the Martin Luther King Papers, speaking on "African Americans on the Road to Freedom." Touching one of these scholars' portraits leads directly to a video interview. At the end of the interview, the portrait screen reappears. Each of these scholars interprets the 1850's in California from a different perspective. Visitors have the option of exploring all three interpretations and drawing their own conclusions in light of what they see in the exhibition and what they always "knew" about the Gold Rush. At the end of each video presentation, visitors can use touch-buttons to select another issue, go back to the previous screen, or return to the main menu.

Solve Mysteries in History

Although not part of the initial concept, computers and games are such a natural pair that Mysteries in History emerged during the development process as a way to capture the imagination of our younger visitors and to encourage exploration of the exhibition.

Visitor access to Solve Mysteries in History begins with a voice over introduction showing three mysteriously wrapped packages. Visitors touch the screen to choose one of the packages. A screen showing their package choice has "The Rules" which explain the scoring system. Then, visitors have four clues, one after the other, to guess what is inside the package. The first and third clues are written; the second and fourth clues are images. For example, in one witnessed instance, a group of adults and children chose a mystery to solve. The first clue was "You can ride it but it goes nowhere fast." The adults immediately guessed the carousel horse on exhibit not far from the computer station. But that is the wrong answer. The next clue is a detailed image of part of the object. The youngsters looked at it, fanned out into the gallery, found the object, and came back reporting that it was some kind of saw. They were right, the answer being a bicycle-powered jigsaw. Delighted laughter ensued, and the next mystery was instantly called up.

Options after guessing the right answer include "More Information" to see the Curator's File card on that object; "See Video" if a video segment is linked to that object; "Where is it?" if you need help finding the object in the gallery; "Another Mystery," "Previous Screen," or "Main Menu."

System Components

There are three stand-alone History Information Stations, each addressing approximately one third of the exhibition: Pre-History to 1848, 1848 to the Turn of the Century, and the Twentieth Century. Each is installed in the appropriate section of the exhibition in a custom designed cabinet that allows the screen to be tilted to various angles for convenient viewing. Overhead signs identify the location of each station and the historical time period it covers.

Each of the three stand-alone History Information Stations is composed of the following hardware:

- Mitsubishi Diamond Scan 19" monitor (HC3905)
- Elographic touch screen (E274)
- Acer 286 PC with 40mb hard drive
- VGA 80 column text overlay board
- Sony videodisc player (LDP-1550)
- Realistic integrated stereo amplifier and speaker

The custom software and system configuration was developed by New England Technology Group, Cambridge, MA.

Independent Producers Services, Inc. of Berkeley, CA, filmed the videotaped interviews totaling 1 hour 27.5 minutes. Ace Design of Sausilito, CA, provided graphic design guidelines for the computer screens to integrate them with the existing graphic vocabulary of the exhibition.

Funding for the system was provided by the S. H. Cowell Foundation, the National Endowment for the Humanities, Mervyns, the Women's Board of The Oakland Museum, the History Guild of The Oakland Museum, and the City of Oakland.

Context - The Oakland Museum

The development of the system is best understood within the context of The Oakland Museum, the "Museum of California," a multi-disciplinary museum presenting a unique view of the California experience from the shared perspectives of art, history and natural sciences. Internationally acclaimed for its innovative architectural design by Kevin Roche, and for its concept as a regional museum, the museum blends three main galleries, temporary exhibition galleries, classrooms and other facilities within a 7.7 acre urban setting of terraced gardens and open courtyards. The City of Oakland, the community that supports The Oakland Museum, is one of the nation's most racially, ethnically, and culturally integrated. The museum's history is based in a strong sense of community involvement, with a tradition of providing programs and services for a diverse multicultural audience.

The Oakland Museum's 28,000 square foot Cowell Hall of California History presents the exhibition "California: A Place, A People, A Dream." Visitors may explore California's rich past from prehistory to the present. Here they can meet the people who have shaped California--natives, adventurers, wealth-seekers, health-seekers, colonists, settlers, newcomers, old-timers, sun-worshippers, reformers, upper class to under class--people of all colors and the dreams they have pursued. Here they can explore the forces that have shaped California--the environment, the Gold Rush, earthquakes, wartime, the computer chip, Hollywood, social and political protest, countercultures, the automobile, discrimination, leisure and the benevolent climate, freedom and opportunity.

The exhibition, designed by Gordon Ashby, was initially installed in 1969 with a new 20th century gallery that opened in 1984, is a combination of wall panels with text and images, enclosed cases, open platforms and period rooms, displaying some 6000 artifacts. The objects are there to tell a story, grouped in thematic assemblages with interpretive text that focuses on the larger issues of California's past rather than the significance of individual objects. A revolutionary concept in 1969, the decision not to label individual objects grew out of the vision of the exhibition as a story-telling place about cultural history, not a place about object classification. The juxtapositions of artifacts, the aesthetic interplay within artifact groupings and the overall power of assembled objects to tell important thematic stories far outweighed the traditional emphasis on isolated understanding of particular objects. In addition to the thematic text, docent tours, a gallery handbook, and special programming provide a variety of interpretive formats for the visitor to use.

The exhibition remains dedicated to the use of assembled objects to tell history, but one frequent request from visitors has been for information about this object or that object. What is it? How or when was it made? How does it work? This interest was not unexpected, and from the beginning, we realized that something would have to be done. We wanted to use this curiosity about individual objects as a catalyst to stimulate interest in history. We wanted to answer these questions so that attention could be expanded beyond the specific. We wanted to credit donors of artifacts as well. The challenge of addressing these needs without blurring the exhibition's focus provided the impetus for development of the interactive History Information Stations in the Cowell Hall.

Since opening the system, we have received many inquiries that use technology rather than content as a starting point. It is important to emphasize that our starting point was not technology, not that we needed to incorporate interactives into the exhibition. We did not ask, "We need an interactive computer. What shall we make the computer do?" Indeed, we first explored how we might provide individual object identifications in printed guides either mounted periodically in the gallery or available at the front desk. Printed guides were in fact produced as docent manuals. We also developed a complete graphic scheme for discrete group labels to be placed throughout the exhibition. After much discussion, we concluded that neither of these would meet our needs and that the number of objects and the amount of information we wanted to convey could best be handled by a computer. Moreover, we felt this solution would have the least negative impact on the exhibition aesthetic.

Concept Devlopment

Having made the "computer" decision, we began to explore how this medium might serve various objectives within our interpretive programs. One of our earliest decisions grew out of two previous, disastrous attempts to develop computer programs in-house with contract programmers. Not wishing to repeat such painful experiences, we decided that museum staff would stick to content issues and that we would seek a firm with extensive experience in developing interactive systems to provide a turnkey system addressing both hardware and software needs. We were absolutely uninterested in the enthusiastic "Oh I can do that" promises from local computer hacks who offered inexpensive but inexperienced solutions. Our staff does not include computer experts; we are historians and anthropologists. Recognizing that fact, and designing the project around our abilities and limitations, was a key element in the success of the project.

So we began to address content issues. The first objective was provision of information about each object and image on exhibition. Freed from the prospect of 6000 tiny printed labels overwhelming both the visitor and the exhibition, we developed an approach to interpreting individual objects that provides both basic identification such as object name, materials, maker, dates, function and so forth, as well as contextual, anecdotal, and interpretive information to direct the visitor's attention beyond the object as object. For example, the Wooton desk on view intrigues visitors as a complex example of Victorian furniture loaded with pigeonholes, drawers, cubbies, and moving parts, but it is also an introduction to the massive changes in information handling that were the result of developing transportation networks and mass production capabilities emerging in the mid-19th century. The computer's ability to invisibly handle large amounts of text, such as that required to explain about the Wooton desk, allowed us to go beyond the constraints of typical museum labels and to utilize a wide range of information types and sources to add new dimensions to the educational possibilities of the exhibition.

Two additional objectives grew out of the fact that since we would be using a computer with a videodisc, we should take full advantage of its capabilities. One of the major interpretive goals of the exhibition is to encourage visitors to see ordinary people like themselves as part of history-making. We have often invited Californians to share their experiences as part of public programs offered periodically in the exhibition. The computer offered us a way to make these stories and experiences available on a continuing basis. Videotaped interviews with Californians whose stories and, in some cases, objects are included in the exhibition would allow us to bring very personal perspectives to bear on the understanding of history. For example, Chizu Iiyama was a college student when she and her family were sent to a World War II internment camp. Her story on videodisc adds a powerful component to the exhibited artifacts and interpretive text in the gallery. Julian Lang, a Kaork Indian, can explain the significance of the "Big Guy," otherwise known as the pileated woodpecker, whose red head feathers figure so prominently in the development of artistry and wealth among the Indians along the Klamath River. His presence alone helps to dispel the myth that Indian culture is a thing of the past. Joe Bailon, caressing the candy apple red custom car he created, can tell first hand stories about car culture in California and why, after all, anyone would want to have a custom car. Although the typical visitor would not gain a sense of the whole system during a given interactive session, we were concerned that the system include a representative balance of experiences reflecting a range of racial and ethnic backgrounds, cultural points of view, innovative and mainstream lifestyles, and everyday and historically significant experiences. We wanted our very diverse audience to find themselves here as a part of the museum. Museum staff did, of course, choose the people to be interviewed but beyond that informants were encouraged to choose how to tell their stories and what was important to say. And in the final editing of the hours of rough videotape, we were guided by a respect for their opinions and their sense of importance. These first hand perspectives, presented in the context of a museum exhibition, elevate personal experience and encourage people to see their own lives as part of the history of the future. They also give an immediacy to the exhibition that cannot be achieved through objects and text alone.

A second objective growing out of the potential presence of a videodisc was an opportunity to explore recent historical scholarship and differing interpretations of California history. The exhibition itself adopts a middle ground to provide an overview of a large and complex story stretching from pre-history to the present. Of necessity, it leaves untold many particular stories and points of view. We invited two academic historians to assist us in developing a means to incorporate historical scholarship that had been undertaken since the initial installation of the exhibition in 1969. What grew out of these discussions was a recognition of the need to include historical debate. Their experience in teaching history to college students suggested that we should contrast differing interpretations to remind visitors that "History" is not a cut and dried answer but rather a selection of facts used in presenting a point of view. We hope to encourage visitors to use critical thinking by presenting various views of the same subject, and even questioning the implications of the exhibition itself. For example, using videotaped interviews, Dr. Ruth Cowan takes issue with the Victorian exhibit replete with fancy furnishings, chandeliers, and silk gowns. She notes that something is missing from this exhibition and goes on to describe the servants necessary to support this lifestyle. In another example, Dr. Jim Holliday addresses the 1850s Gold Rush from the Yankee viewpoint of its opportunity for wealth; Frank La Pena presents the Indian viewpoint of the Gold Rush as genocidal and cultural disaster; and Dr. Clay Carson looks at 1850s California as an opportunity for African Americans to seek life and opportunity outside of slavery. In developing these interviews, we were committed to incorporating other points of view in the exhibition, and to that end, the scholars were given wide latitude to define the issues they wished to address. The ground rules were that the topics had to relate to the exhibition in some way and that the medium required short statements, not 50 minute lectures. Beyond that, we worked closely with the scholars in developing outlines and shoot sites for their presentations but definition of content and point of view was up to them. Their views are presented in the context of the exhibition not as answers but as issues to inspire questions about what people see in the exhibit and what they have always "known" about history.

The development of the content was largely dependent on our intuitive and experienced concept of what a successful museum exhibition should address. Technology was a helper in achieving these goals, not the driving force. Our assumption--a very generalized one--was that technology would be able to meet our content objectives. And our decision was that computerized bells and whistles beyond our defined content objectives were not of much interest. Although we visited model interactive computer installations throughout the country, from the Getty Museum to Epcot to the AAM vendors' hall and places inbetween, we did not develop a prototype nor did we do a formative evaluation regarding the use of technology as a medium. We did apply the same criteria to the content development for the computer system that we would apply to the development of an exhibition storyline. We found useful similarities in the need for a compelling people-oriented story, for content based on a solid foundation of research and interpretation, and, in the end, for a design that complemented the content. I do not suggest that this is the only, or even the best, approach. However, jumping into the design phase before dealing with the compelling content or the research and interpretation does not work well for either exhibitions or interactive computers.

The concept described above was incorporated in our request for proposal which we distributed to firms which we knew had implemented successful interactive programs at other museums. New England Technology Group, whom we selected to work with us on this project, responded to our request with a very specific proposal that suggested to us that they understood the concept and that they could develop appropriate solutions for successfully blending concept and technology. Their response also included a very clear, easy to understand budget which was essential to our development of funding proposals and, in essence, allowed us to proceed.

Concept Implementation - The Museum Perspective (Deborah Cooper)

As everyone knows, concepts are one thing, and implementing concepts are quite another. In order to implement this concept, we had to raise approximately $300,000. We are extremely grateful to the S. H. Cowell Foundation, the National Endowment for the Humanities, Mervyns, The Oakland Museum's Women's Board, and the History Guild of The Oakland Museum for their very generous support.

With funds in hand by September 1989, we began intensive discussions with New England Technology Group regarding the blending of concept and technology. From the museum's point of view, this was to be a team project. We had made a substantial commitment to an interpretive concept that could not be implemented without an experienced partner. NETG brought an essential ingredient in their ability to visual how all this might work. One expression of their vision was the flow chart they produced which we used in every conceivable fashion from staff education to PR to final fund raising. Those of you used to developing interactive systems may take such tools as flow charts for granted. However, please recognize that for at least some of your clients, they are major revelations. When Steve Gregory began to draw the flow chart up on big pages at our first meeting, the proverbial lightbulb was lit as we began to see how to think about the concept in terms of the technological possibilities. The collaboration established early in this project was based, I think, in a balance between passionate commitment to content and consummate skill in shaping, and explaining, that content around successful technological reality.

I said earlier that we were uninterested in bells and whistles. Actually, one bell and whistle did grow out of our early discussion with NETG. If there were going to be computers, there should also be a game. Mysteries in History, a guessing game about objects in the exhibition, evolved out of brainstorms, a good deal of laughter, meetings with cookies and mead, and clues and ideas from a very wide range of sources.

Development of the game was actually fun although, like most of this project, it turned out to be rather more work than anticipated when we said, "Yes, lets do it." A few facts and figures may help those of you about to specify the resources you will need to accomplish an interactive project. My first word of advice is, "Don't underestimate." This is a very exciting medium; ideas and visions grow during implementation in the most compelling fashion.

The development of the curator's file was based on an already completed inventory with accession numbers of the 6000 objects in the exhibition, including the several hundred reproduced photographs mounted on panels. The already completed docent manuals also contained a list with interpretive information about all the exhibited objects and images as well as a detailed drawing of each exhibit unit with each object numbered and keyed to the list. In anticipation of the project, we had also already hired a professional photographer to produce one, and sometimes more, color slides of each exhibit unit. Even given this foundation, it took four people nine months full time, and then some, to research and write over 6000 "curator's cards." The format was defined by NETG to mesh with a successful computer presentation: 20 lines 66 characters long per card maximum, and that included a donor credit line. There was typically one card per object, but many objects also linked to a second card of more generalized, interpretive information. The curator's *cards were not to resemble computer database information, or even typical museum labels, but were to be engaging presentations of wide ranging information written specifically for this purpose. This was a major undertaking, and since we had budgeted three people for eight months, the additional person and month relied on additional funding and a very significant input, unplanned, of regular staff time.*

Production of the videotaped interviews with both the first person Californians and the scholars was awarded to a local film production company based on an RFP we submitted to several firms after we had already raised the funds to produce the video. Hence we were looking for a firm which could work within our fairly arbitrary budget and still be committed to excellence. Since museum audiences are also experienced video-viewers, we were concerned that the production values be very high. Independent Producers Inc. brought their bid within our budget and demonstrated a clear understanding of what we hoped to achieve. However, we both underestimated the amount of work to be performed. Intensive preparatory interviews with the first person informants and even more extensive meetings with the scholars led to six, not the budgeted four, days of shooting all of which occurred in our gallery to establish direct links between the interviews and the exhibition. There were hours of editing too scary to calculate that turned 24 hours of raw footage into 86 rather than the planned 60 minutes of finished video. Overtime on the part of museum staff was largely volunteer but overtime on the part of the video crew required that we raise an additional $13,000 over our original budget of $44,000.

Per our contract with NETG, the museum was required to submit the completed curator's cards as word processing files on floppies, the finished video as a 1" master and 3/4" time coded version, the color slides of the exhibit units, and the final clues and images for the game by May 1. We didn't actually get this all done until sometime in July. So in addition to advising you not to underestimate resources, I would suggest that a flexible opening date is a very handy saving grace to cover underestimates of time.

One final piece of the production was the graphic design for the screens. I have indicated a certain apprehension on our part regarding the use of computers in our gallery: we began by looking for a label system that would have the least negative impact. We wanted the computers to fit into the exhibition seamlessly. To that end, we hired Ace Design, a firm that had worked with the original exhibition designer, to develop guidelines for the graphic design of the computer screens so they would harmonize in color, type face and overall graphic vocabulary with the gallery graphics. Implementation of this process required an infinite amount of patience and dedication to client concerns on NETG's part. It involved the shipment of videocasettes too numerous to count for the review of developing screen designs and long conversations about difficult-to-descibe visual components. It took more time and resources than either of us had estimated. But the end result was that the computers seem an original part of the exhibition rather than an afterthought.

The graphic elements were the final piece of production from the museum's point of view. However, we were mercifully insulated from the production aspects that NETG undertook to produce the finished system.

Concept Implementation - The Producer's Perspective (Jim Oker)

As a member of the company hired by The Oakland Museum to produce the History Information Stations, I can provide a somewhat different point of view on the project, and I of course have a different bias. I see many projects happen each year, and though I try to keep in contact with our past customers, I do not continue to live with the projects. Our ending is just the beginning for our clients. My perspective, however, allows me to discuss issues of general relevance to many other projects.

When I discussed what I would write with Deborah, she thought it would be interesting to other museums to hear how we decided to respond to the museum's RFP. As we put costly hours into responding to RFP's, we must somehow decide which to respond to and which to let by. When we work on exhibits, we strive to archive the goals of our clients, and Oakland had a clear sense of goals which were rather well expressed in their RFP. From my first reading of the RFP, I felt that they had enough momentum to carry the project to completion. Their RFP showed a significant investment of time, and it descried details which indicated clear and thorough thought. Yet they left room for our input. We were able to reply with a responsive and specific proposal. Though the shape of the project was to change and change again as we grappled with further levels of detail, the RFP and our response established a core of ideas and goals which carried through to finished product. Our proposal verified and expanded upon their groundwork, giving both Oakland and funding sources like the National Endowment for the Humanities the confidence to carry out the project.

Once the museum had settled on interactive computer stations, they clearly needed a firm such as NETG. On many projects, our clients want to delegate as much responsibility to us as possible, wanting only to see our work for approval, asking only for changes when we have made factual errors, or interpreted content in a way which runs counter to the viewpoint of their museum. From very early on, we could see that the museum wanted to be involved at each decision point, to be educated to a level at which they could make informed decisions. By insisting on this involvement throughout, they have created an exhibit which fits the Cowell Hall of California History like the last piece in a puzzle.

Though we could have provided the original video production, and have done well with this sort of documentary work in the past, the shooting was to take place on many days scattered through three months of time. We would have had to fly to California perhaps five or six different times, while Independent Producers Services is located close to the museum, and could more cost effectively conform to the schedule of the various people brought in for filming. They had, moreover, solid experience with shooting oral histories of Californians, and had therefore shown an ability to handle the very topics of interest to the museum.

As we began to hash out the details of graphic design with the museum, it became obvious that given their desire to be involved with the finest details of the project, that creating a design that would mirror the look and feel of their gallery was going to involve many iterations, and face to face contact would allow a much quicker completion of the design. Therefore a local designer who had designed for computer screens in the past seemed like the most practical way to design the graphic templates which we would then follow.

The Oakland Museum's History Information Station project blends the talents of four separate organizations.

The Oakland Museum knows their exhibit area. They have spent a lot of time developing a complete history of California as shown by their collection of artifacts. By watching and listening to their public they knew what would make their hall feel complete. As each small decision needed to be made during the project they were guided by their intuitive feeling for their visitors.

In our role as interactive media producer, we brought the technical ability to execute the project combined with interactive media design skills. We listened to the Oakland staff and interpreted their requests into a usable interface as well as a solid computer program.

The graphic design firm, located in Sausilito, has created graphic templates for interactive screens in the past. We provided them with functional screen designs which they altered to match the exhibit hall through choice of color, font, and layout. We in turn took their templates and interpreted them into practical computer screens. It is often difficult to match the typesetting or color on a computer screen to a paper layout. We varied from the templates where necessary in order to avoid colors that bleed in video as well as to fit lengthy text on the screen in a readable fashion. As each of these changes were made, the museum was consulted for input and approval.

The original video producer nearly took up residence in the gallery. They spent several hours with each personality who appears in the program. They made their subjects feel comfortable on camera, then coaxed them into telling their own stories in ways that helped pull together the broader context that the museum had been looking for. After filming, the producers sorted and culled their 24 hours of material in order to edit down into 86 minutes comprised of 64 separate video segments which conformed to our design specifications. The producers worked very closely with the museum during this stage, as only the museum could choose which interesting pieces would fit into the limited space on the three videodiscs. We worked with the original producers to ensure that their work would integrate properly into the whole program.

The map view of each gallery demonstrates the teamwork in action. We considered many alternatives to allow visitors to telescope in on single artifacts (out of a pool of 6000). After having toured the exhibit halls, we decided that starting with a map view of each section of the gallery would be the most practical starting point. From there, visitors would select smaller areas or groups of display cases, then individual display cases, then individual artifacts. We suggested that the museum, in conjunction with the designer, select one landmark object or image for each area to give visitors strong visual clues to help them to decipher the floor plan. These icons, placed in shaded regions, would be the touch targets for each sub-area. Because these landmark icons were each going to be very small, and because at this size the computer screen would not convey fine detail, we suggested that they look only for very simple and graphically bold items. Together the designer and the museum sifted through each area, coming up with candidates which they sent to us pasted up onto layouts that the designer had created for each of the three map screens. Once we had the images on the paintbox, we identified several which were not readable when translated to video. We all went through a few more iterations of this work until we had three video floor plans which the museum felt would allow visitors to quickly identify each area of the galleries.

During the execution of this project, each member of the team could have certainly performed some of the functions which other members provided. Each member, however, respected the unique province of the others, and gave way when necessary. I feel certain that we each disagreed with others on certain fine details which are now in the final program, but by sensing when to press a point and when to yield, I feel that we created an exhibit which reflects a wide range of skills and experience.

As we neared the project's completion, I was flabbergasted by Deborah Cooper's stamina in dealing with each of many easy to let slide details. Many people were involved in the project at both NETG and the Oakland Museum. Our staff doesn't enjoy seemingly endless repetitive detail, and this project offered much of it. As the main point of contact with the museum, there were days when the programming crew cringed as I came through the door, knowing that I had a new list of issues from my latest discussion with Deborah. I felt that we needed to carefully sift through all the museum's expectations in order to ensure that the finished exhibit would have a fair chance at working.

In some ways, I "championed" the project at NETG, much as I believe that Deborah championed the project at the museum. We both felt that the project could work, that at it's core it was a good and viable idea. We had both invested creative energy even before the project had been funded. Because the museum had carefully thought through their goals and expectations, their suggestions bore an authority that those of some other clients have lacked. By striving to share the essence of the museum's concerns with the programmers, we were able to close a feedback loop between our two organizations.

How We Selected the System Configuration

The exhibit draws upon two fundamentally different sources of information: motion video which is stored on a videodisc, and lengthy text which is stored on a hard disc drive. Motion video, as seen in nearly every American home, is called NTSC. NTSC is a compromise of features which displays color moving video in a very acceptable fashion. However, fine details are lost on an NTSC monitor. The text we are used to seeing on a television is very large, and therefore looks quite clear. The Oakland project, however, required the display of much smaller text in order to avoid forcing visitors to flip through endless screens in their pursuit of details of each artifact. The museum wanted to display a standard screen of information which would answer many basic questions, followed by a second screen when there was a special story to tell about an artifact. In order to display their text information clearly, we could not use an NTSC monitor, but wanted instead to use a color computer monitor which can clearly display the type of text seen in word processing programs. We chose to use the VGA standard video display, as there are some computer graphics cards on the market which will take in NTSC signal, turn it into a VGA signal and combine it with very crisp text for display on a VGA monitor.

We chose to use a 286 class computer because it has just enough speed to load the full pages of text at an acceptable rate. A slower computer would have frustrated visitors, while a faster one would have wasted the museum's money. (The optimal choice of computer varies from application to application. Computer graphics, as opposed to graphics which are stored on a videodisc, tends to call for faster computers)

Because the museum intends to continue to update the text information stored for each artifact, we first considered networking the three stations in order to keep one master database. Due, however, to the cost of running network cable in the exhibit hall, we chose to set up three independent stations, each of which would house its own unique database. We traded the cost of two extra hard disk drives against the cost of three network interface cards and the cost of running network cable. Another benefit of the independence of the stations is that if one station has troubles, the other two won't be effected by them.

We chose a videodisc player which we had found to be reliable in the past. Where possible, we created the menuing graphics in the video studio on a Quantel paintbox. The paintbox offers better color resolution and paint effects than the computer graphics board in the system. Moreover, complex images stored on a videodisc can be loaded in a fraction of the time required by computer graphics.

We also created a plain videodisc backdrop for the screens of computer text and graphics. When we used computer graphics overlay for part of a screen (a text screen, for instance) we used the computer graphics for the entire screen. We felt that it was important to maintain a consistent look and feel within individual screens. We did, of course, strive to match the common elements seen in both computer graphics and videodisc (such as the control bar which appears at the bottom of all menu screens offering such choices as "previous screen" and "main menu"). We felt that it was very important that once a visitor had learned how to use a particular control, they should find its look and use to be consistent throughout the program.

The Interactive Program Design Process

When we began to work on the History Information Stations, we needed to work out the design of the program before starting any production activity. We had a sense of the information the museum wanted visitors to access. We had a sense of the museum's aesthetic criteria. And we had an overriding design philosophy developed over many past projects, as well as through studying the use of our own work and the work of others. While it would take a book to even attempt to lay out an interactive design philosophy, or even to suggest a "how-to" approach, I can at least offer a sense of our process and the tools we used to communicate our ideas to the museum.

As clients describe their goals to us we begin to imagine in our minds the various designs which might be appropriate. The early steps are perhaps best described as brainstorming. We make use of what we have seen or done in the past. We also try to come up with something new by deriving our design from the requirements of the task at hand. As ideas arise we develop them until we are either satisfied that they are solid or have found an unresolvable flaw.

As we work out ideas we create very rough flowcharts which help to visualize each approach. They are as quick and temporary as sketches drawn on napkins (often they are drawn on napkins). Flowcharts are one of the most fundamental communication tools of our craft. A good flowchart will quickly give even an untrained viewer a sense of what sort of choices the visitor will have when using a program. When paired with a written treatment of each flowchart element, the flowchart becomes the "blueprint" for an interactive project. The flowchart which we finally settled on is included here as a diagram. Note that it shows the logical flow of the program, though it doesn't describe each and every pathway which was included in the final project. This level of detail was adequate to communicate our ideas to the museum. The details were filled in much later as we looked at the film footage, the photos of display cases, and so forth.

For the HIS project, we first attacked the problem of how to let visitors select from about 6000 objects. Perhaps the most challenging aspect of this part of the design was figuring out how to judiciously use the limited resolution of video images in order to allow visitors to select from a large amount of information. We assumed that though visitors would have strong motivation (we were creating this part of the program for the visitor who has a question regarding an artifact, thus showing motivation), they would nevertheless get quickly frustrated with a cumbersome interface. Some ideas which popped up during early brainstorming include: taking visitors on a motion video tour through the gallery during which they could touch display cases to select them -- too expensive, too time consuming to sit through the tour; allowing visitors to sift through views of the gallery, moving from wide angles into specific cases--too difficult for most visitors to grasp the wide angle views, too much time spent sifting; asking the museum to put numbers by each item so that we could ask visitors to type in the number--simple for us but horrible for both the visitors and the museum; and allowing visitors to step through the display cases one by one--again, quite unwieldy for the visitors.

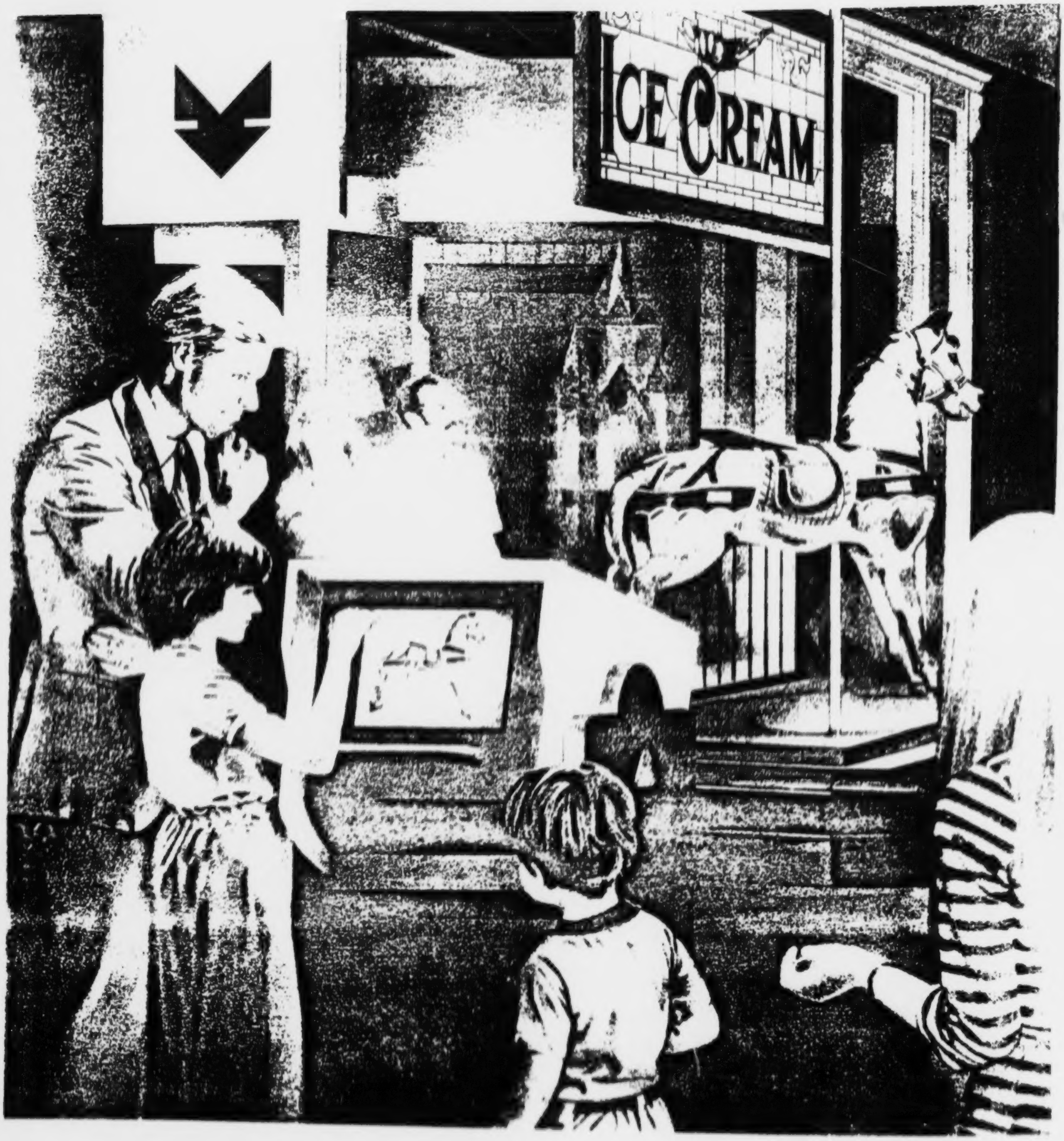
One of our earliest ideas remained a clear favorite -- to first offer a map with landmark icons to help visitors select the area in which they found the item in question. Once they select the area, we could then show a montage of display cases at a large enough size to allow visitors to distinguish between the cases. They would next select the case, then finally the artifact in question (though in many cases the visitor may have to either flip through a few views to find a particular object or select an artifact rich area for a further blow-up). We liked this design for a few reasons. Visitors seem in general to be able to understand well designed graphic floor maps of galleries (if we were wrong in that assumption, most museums in the country have got even greater orientation problems than I have heard about). A lot of information is conveyed in one map. The map allows the visitor to filter out most of the gallery from the decision making process with one touch of the finger. Once the choices have been so filtered down it is relatively easy to select between cases and then items in a case. Visitors can reach the information screen in three touches for most artifacts. Given such a quick way to access one of thousands of items, even if visitors make a few wrong choices along the way, they could back out and try again without getting too frustrated to continue.

With the problem of selecting artifacts settled, we worked out the way of getting from artifact screens to video segments, as shown in the flowchart. This aspect of the design seemed quite obvious given the desire of the museum to allow visitors to see video segments which were relevant to certain artifacts.

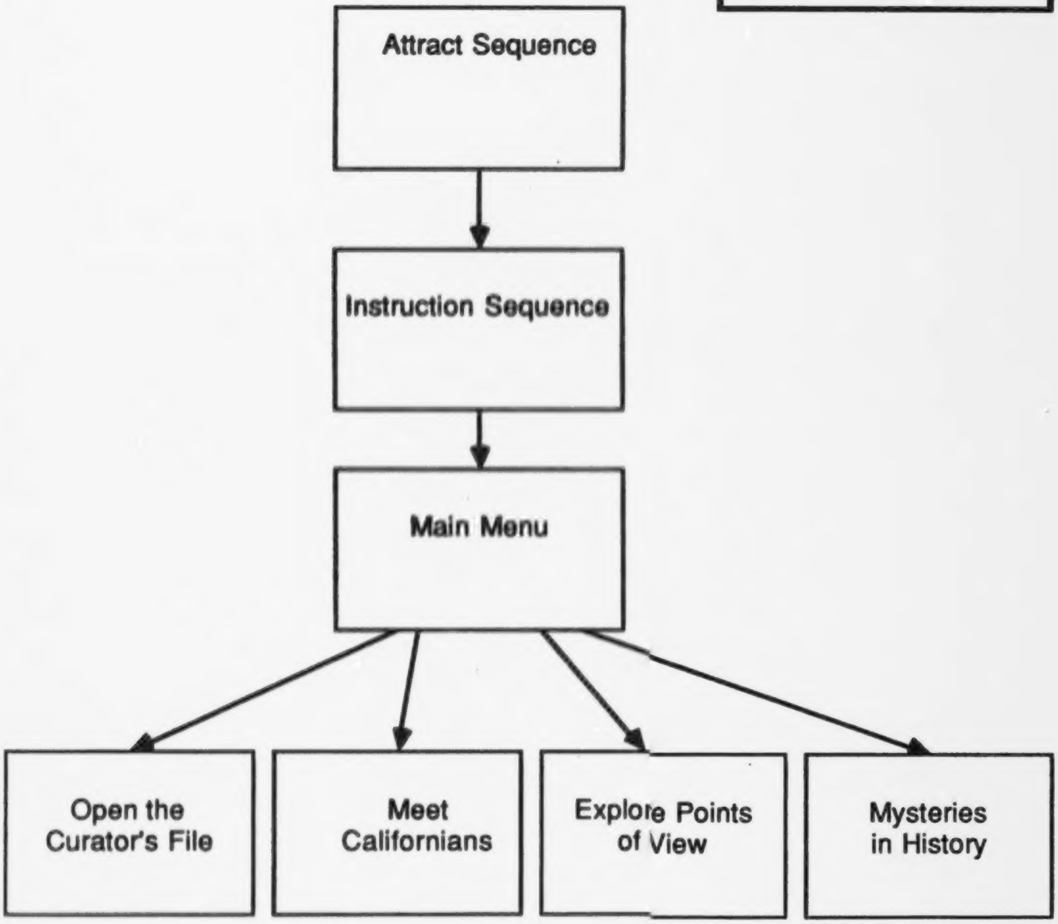
We felt quite certain that many visitors wouldn't care to explore the artifacts at length, and therefore might not see the very interesting video material which some artifacts lead to. The video would probably be of interest to a higher percentage of the museums visitors than would be the artifact text information. We suggested to the museum that the program provide an alternative way to access the video segments. Given that the segments were filmed of "Californians" and "Scholars", these seemed like natural ways of giving visitors choices of what to see. These were made choices from the top-level menu along with looking at individual artifacts (the "Curator's File"). Following further discussion with the museum, we settled upon the sub-choices within each of these sections as shown in the flowchart.

The museum also felt that given that they were using a computer system to solve their problem, they should do something to satisfy their visitors' expectation that computers provide games. The game element, however, should do something to put the visitors in a relationship with the artifacts. The museum first suggested hiding an artifact behind a layer, and allowing visitors to scratch off the layer until they could guess what artifact was being displayed. For reasons of budget, we suggested a somewhat simpler approach from a programming standpoint. We worked with the museum in meetings to finally arrive at "Mysteries in History" which presents a sequence of clues which challenge visitors to guess with as few hints as possible. Once they find out what the artifact is they can opt to see the location of the item highlighted on a floor plan as well as to see the text information stored for the item. By bringing this information into the game, visitors are encouraged to go back out into the gallery with an observant attitude. While the game is fun, it involves visitors with the exhibition rather than distracting them from it.

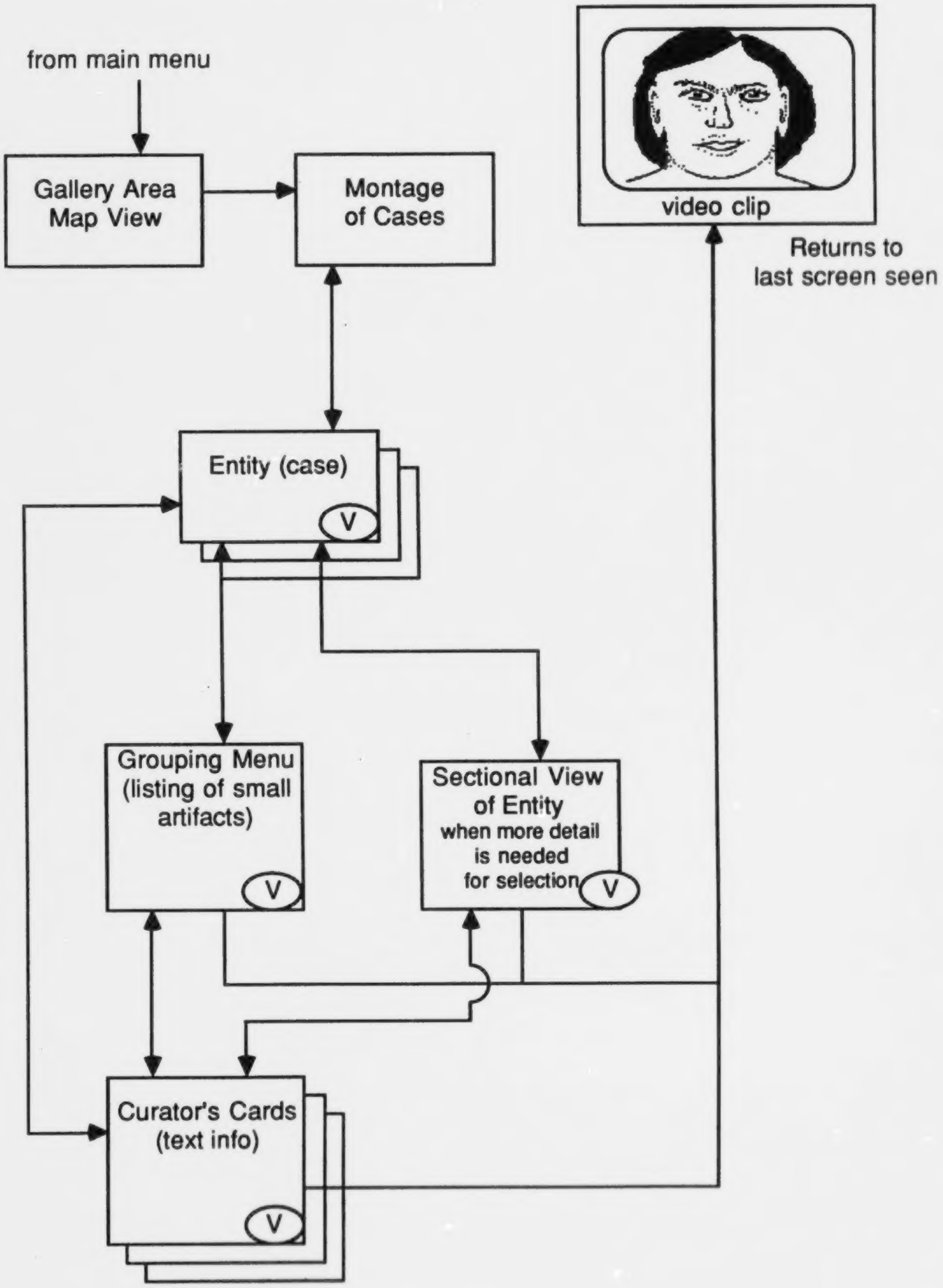
The History Information Stations opened to the public on November 15, 1990. Response on the part of staff, our docents, and the public has been enthusiastic. As one newspaper reporter wrote after going to the museum to see the new "gizmos," "Came away with mixed emotions. As for instance, inspiration, astonishment, sadness, nostalgia, curiosity and amusement." Computer technology has indeed supported our goal to successfully expand the interpretive potential of our exhibition, engaging visitors in a more rewarding journey through California history.


ICE CREAM

Interactive flow chart for the Vistior Information Stations.

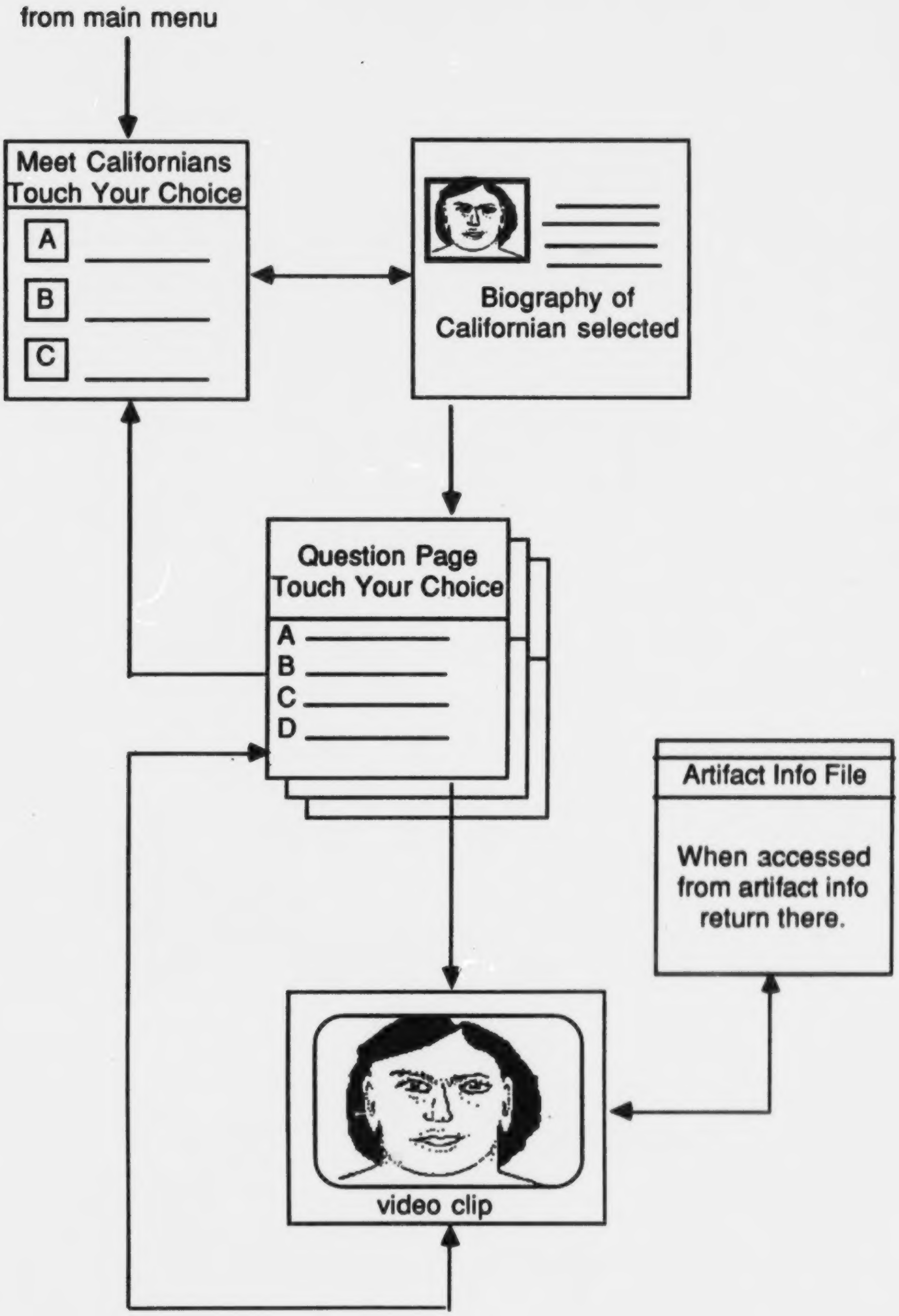

Attract Sequence
Instruction Sequence
Main Menu
Open the Curator's File
Meet Californians
Explore Points of View
Mysteries in History

Open The Curator's File

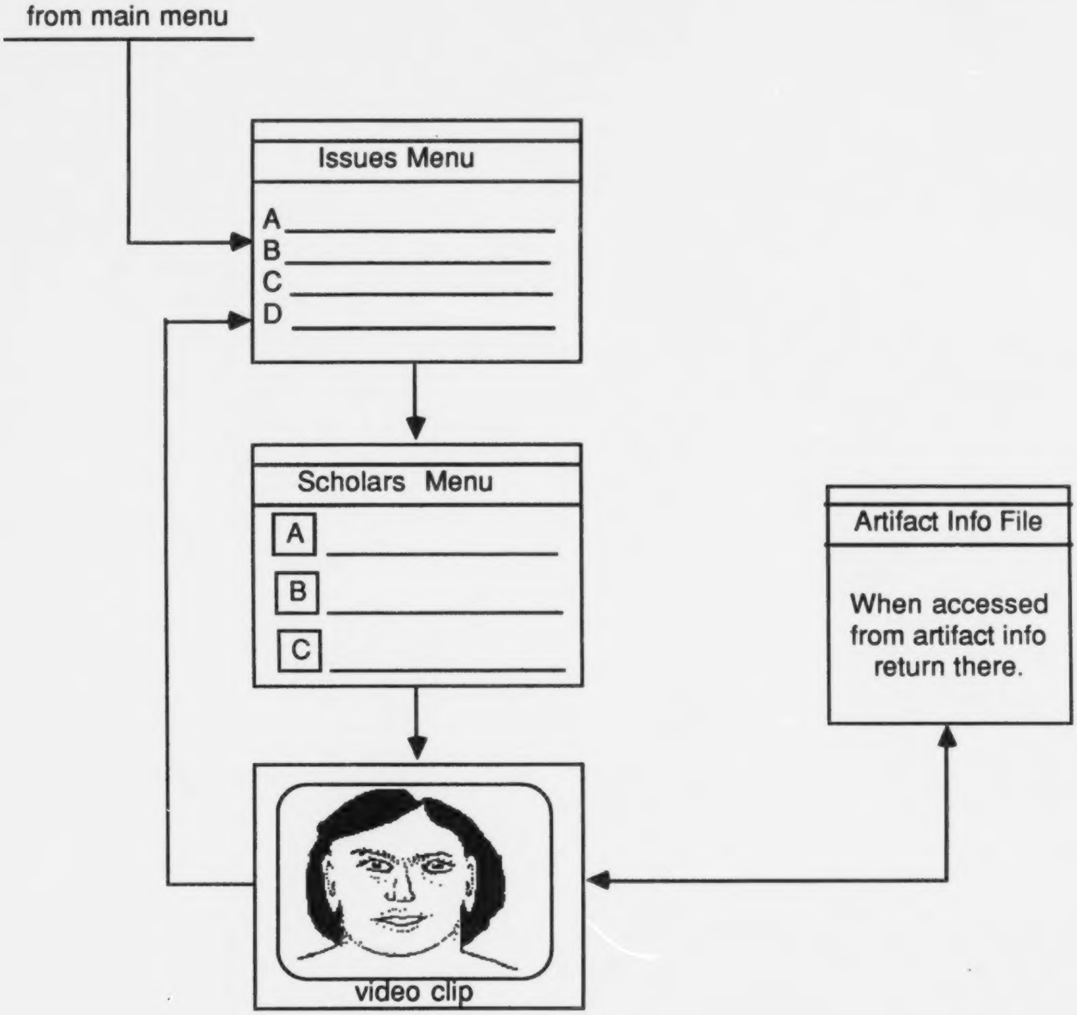

from main menu
Gallery Area Map View
Montage of Cases
video clip
Returns to last screen seen
Entity (case)
V
Grouping Menu (listing of small artifacts)
V
Sectional View of Entity when more detail is needed for selection
V
Curator's Cards (text info)
V

Ⓥ - Indicates access to video clips

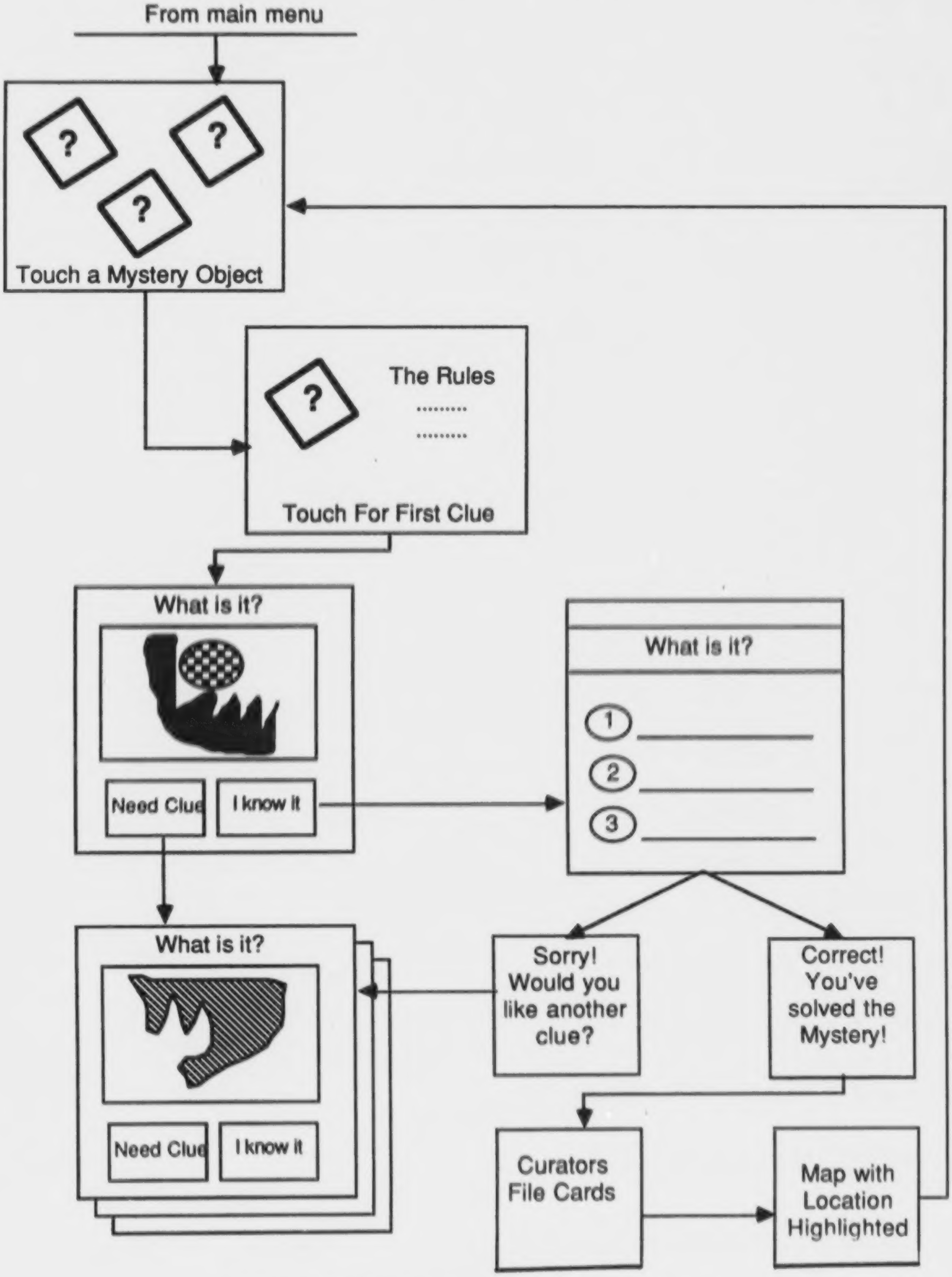
Meet Califomians

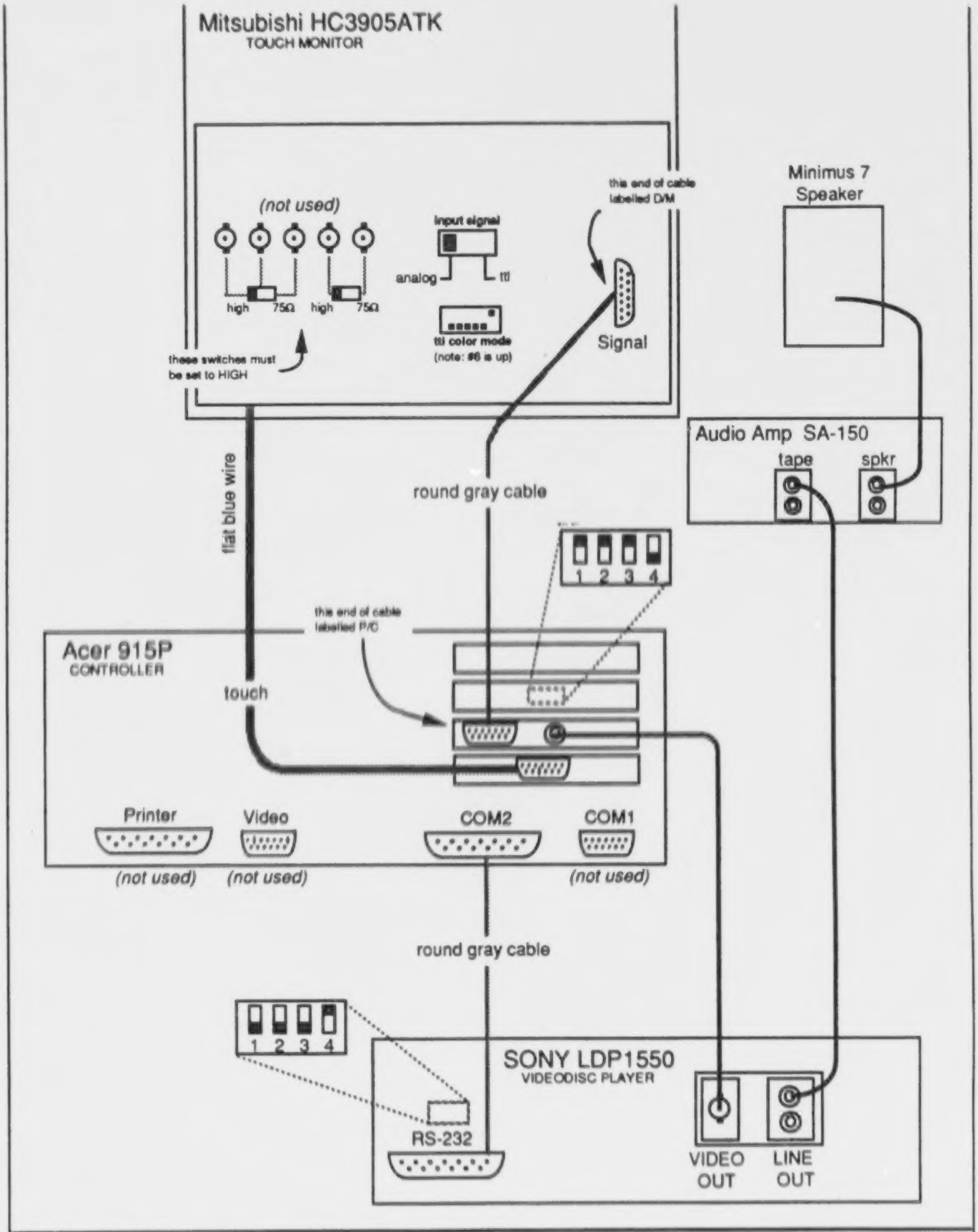

from main menu
Meet Californians
Touch Your Choice
A
B
C
Biography of
Californian selected
Question Page
Touch Your Choice
A
B
C
D
Artifact Info File
When accessed
from artifact info
return there.
video clip

Explore Points Of View


from main menu
Issues Menu
A
B
C
D
Scholars Menu
A
B
C
Artifact Info File
When accessed from artifact info return there.
video clip

Mysteries In History


From main menu
?
?
?
Touch a Mystery Object
?
The Rules
....
....
Touch For First Clue
What is it?
Need Clue
I know it
What is it?
1
2
3
What is it?
Need Clue
I know it
Sorry! Would you like another clue?
Correct! You've solved the Mystery!
Curators File Cards
Map with Location Highlighted


Mitsubishi HC3905ATK
TOUCH MONITOR
(not used)
high
75Ω
high
75Ω
these switches must be set to HIGH
input signal
analog
ttl
ttl color mode
(note: #6 is up)
this end of cable labelled D/M
Signal
Minimus 7
Speaker
Audio Amp SA-150
tape
spkr
flat blue wire
round gray cable
1 2 3 4
this end of cable labelled P/C
Acer 915P
CONTROLLER
touch
Printer
Video
COM2
COM1
(not used)
(not used)
(not used)
round gray cable
1 2 3 4
SONY LDP1550
VIDEODISC PLAYER
RS-232
VIDEO OUT
LINE OUT

SYSTEM DIAGRAM | THE OAKLAND MUSEUM

Computer-Assisted Drafting and Design

Programs for Presenting Architectural History and Archaeology

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The computer revolution has been going on long enough now that no one attending these meetings would be surprised to hear a discussion of any one of several forms of computer-generated "reality." A few years ago the phrase was walk-through or fly-by for a computer-simulated journey through space. Today the phrase is virtual reality - a term which conjures up thoughts of versions of reality - whether true-to-life or imagined - which can be created on the computer screen.

A virtual world is simply a computer-generated scene which simulates a physical world to a greater or lesser degree, depending upon whether one includes elaborate paraphernalia for enhancing the sense of reality, simply a computer screen, or some middle level of equipment. In any case, the computer creates a sense of verisimilitude which can be truly awe-inspiring, and we can all imagine the wonder which can be brought into a museum if the visitor can participate in such a process and truly see the setting from which objects came - whether that be an individual building or a complex urban landscape. To give one simple example, imagine what a difference it would make if the British Museum could take visitors to Athens and let them see the Elgin marbles as if they were standing on the Acropolis in the Fifth Century B.C. rather than in a museum in modern London.

At the root of a virtual world (or a walk-through) is an image or group of images of the world being portrayed. The root image may be a manufactured one, made up completely of whole cloth, or it may be a real one, carefully made to represent reality. If the latter, the root image must finally be based upon dimensions and spatial positions so that it can conform to reality.

This is where computer-assisted drafting and design (CADD) programs come in, because these are the programs which can create the root images for virtual reality systems - root images based on the real world rather than an imaginary one.

CADD programs were developed for architects and designers; so they are ideal for representing real-world objects. Indeed, good CADD programs are fully 3-dimensional (as they must be to provide appropriate information for virtual reality systems). They can deal with complex surfaces, and they make it possible to represent virtually any real geometry with accuracy and precision. In fact, the representation is so full that it is best to refer to it as a model; nothing else expresses the completeness of the representation.

The computer model of a building can be so full and complete that one may even ask the computer to give dimensions between points or to give the exact coordinates of a single point. Provided only that the data collection and input process is good, any dimension or position in space can be accurately reported. The accuracy is a natural result of the fact that the computer does not store the dimensions or locations at a reduced scale; all information is stored at full scale so that no precision, once gained, will be lost.

This accuracy is important to our virtual realities, because it means that, with CADD at the core of a virtual world, we can be sure that the images we create, the realities we simulate, are true reflections of what has been found and studied, not idealized or casually created images intended only to give the impression of reality. A CADD-based image of the Parthenon must be as accurate as the information used to create the original model, and one need not fear that there have been freedoms taken with the actual information.

It may seem pedantic to worry about the level of accuracy which lies at the heart of these virtual worlds. Their purpose, after all, is to give an impression of the physical world; for most purposes the difference between a CADD-based and a more casually produced virtual world might well be imperceptible to the typical user. In some ways, it surely is pedantic, but it is important that we use the technology self-consciously, that we take care not to let the machines seduce us. By insisting on CADD-based images, we can help to assure that we do not find that we have, in the end, allowed ourselves to let scholarship slip as if it were necessary to have the high-tech results.

There are other important reasons to insist upon CADD as the base for any virtual reality systems to be used in museum settings. CADD properly used for archaeological sites or architectural monuments provides a particularly important tool to enhance understanding. This tool is the segmentation of the CADD model and the consequent ability to display specified segments of the model on command.

Let us turn again to the Parthenon as an example of the importance of this data segmentation. The Parthenon has been a temple, a church, a mosque, a harem, a gunpowder magazine, and a tourist attraction. We have remains which belong to all periods as well as remains which belong to one or another individual period, and we also can infer now-missing material from each of the periods on the basis of remaining material or other sources.

Since we have material from so many different periods, it is helpful if not essential to divide the model into segments so that each segment contains only material which was used in a common period or a common group of periods. We would then have a segment for material which was common to all the periods, a segment for material used on the temple alone, a segment for material used only on the mosque, and so on. Having so segmented the model, it is then possible to have the computer show only selected segments (called layers in a CADD system). One could, then, select only those segments or layers which were used in the temple, and no others would be displayed. The same could be done, of course, for the mosque or the church.

But the segments of the model can be even more helpful, because we can also put reconstructed material of a given period in its own layer so that the church, for example, may be shown with only the material actually remaining in situ or with that material plus the reconstructed material required to finish it off. (Please note that this reconstructed material must also be entered into the computer as dimensioned physical objects, not just drawn or sketched additions to the model.) Furthermore, we can keep more than one scholar's version of the reconstructed building in the model at once, simply by putting the differing reconstructions on different layers.

Imagine the result. The model, properly executed, provides all the extant parts of all the phases of the Parthenon as well as the reconstructed parts of each phase, including competing versions of those reconstructions. The visitor to the museum with such a model positions himself to view the model, selects the time he is interested in, selects the reconstructed version or only the in situ material, and then views the model from wherever he likes. He can move about in space to get a better view - even entering the building to look around the inside. Then, if he is viewing the reconstructed building, he can strip away the reconstructed portions and see only that which remains in situ today.

It is possible to go even further with the data segmentation. Portions of the building may be placed on different layers according to date or phase, as has already been described, but one may also make distinctions according to material (limestone vs. marble, for instance), use in the building (door frame vs. column drum), condition (whole or damaged), or any other criterion the model builder chooses. So, in addition to the possibilities already mentioned for the Parthenon, one might ask to see only the foundations, only the marble portions, all portions not of marble, or only the colonnade. The possibilities are virtually endless, but the system is so flexible that it is easy to call up or exclude layers in large groups or individually.

As exciting as this is for a building, it is equally impressive when used to model an excavation. Architectural remains, small finds, artifacts of any type, can be put into the model and placed on separate layers. They may then be seen together or separate, in groups or individually, and the entire excavation or any part of it can be examined at will. Segments may be based on excavation season, original date, type of find (architectural material vs. coins vs. animal bones), and so on.

It should be made explicit that what one may see on the screen one may reproduce on paper - with relative ease and at modest cost. The museum goer can take home a copy of his own unique view of a model to remind him of his visit - and to keep reminding him of what he learned.

All these possibilities depend only upon the features of CADD. Virtual reality systems and rendering programs add the possibility of photorealism to CADD, which can produce line drawings without their aid. But at the core of either of the photorealistic processes must be a CADD model. CADD is the necessary starting point for both systems.

CADD is also the scholar's most valuable tool for recording the features of buildings and excavations. Since measurements are maintained at full scale and completely three-dimensional models are created, the CADD model is by far the most effective form of record-keeping. It also provides important advantages for publishing the work of the archaeologist or architectural historian. Therefore, the creation of a CADD model of an archaeological site or an important building is of benefit to the scholar himself, provides a valuable tool for any museum wishing to put it to use, and will serve as the base for photorealistic images in the future. So the future may point toward virtual reality and rendering displays, but in the present, with CADD, we can already add immeasurably to the ability of the museum goer to understand the world from which our objects come. We should not be waiting for virtual reality; we should be putting CADD to use now with the understanding that it will be the basis of more realistic systems to come and that it serves important purposes independent of the photorealistic display technology.

Electrifying Shakespeare:

Modern Day Technology in a Renaissance Museum

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Playing With the Stars

Have you ever dreamed of acting Shakespeare with the stars, of striding the boards of the National Theater with Vanessa Redgrave, or perhaps of playing an intimate little scene with Laurence Olivier in Hamlet? If plans work out, you may be able realize those dreams in a Shakespeare museum due to open soon in London.

Here's how it would work. You would be asked, in a computerized exhibit, to choose your favorite actor or a character in a specific Shakespearean scene. Then, a filmed image of the character or actor you chose would appear on a large wall screen and begin addressing his or her lines directly to you. When your turn to speak comes, all you would then do is to read out the lines scrolling by at the bottom of the screen. As you acted your heart out, your performance would be recorded by a hidden video camera.

Now, for the magic! Once the scene is completed, a computer takes both films, of you and of the actor, and cunningly combines them on one screen. We film the actor doing the scene both from the front, in a full-face view, and from the side. We leave space on the image for the character to whom he talks. It thus appears that you and Sir Laurence are working together on the same stage! Finally, you can leave the museum with a taped record of your glorious thespian moment safely tucked under your arm.

Possible? Not yet, but it is on the drawing board as one of the forty or so designs for interactive exhibits at the museum created last year for the International Shakespeare Globe Centre (ISGC) for use in their proposed Shakespeare museum. Hopefully, these exhibits will create a world as alive, as unexpected, and as user-friendly as that of Shakespeare's own plays.

What is the International Shakespeare Globe Centre? The International Shakespeare Globe Centre (ISGC) will be a formidable theater, museum, and research center located on the south bank of the Thames, on the site of Shakespeare's original Globe theater. At the center of the planned complex will be a new version of the Globe reconstructed in authentic detail. After a hiatus of three centuries, it will be possible to perform and see Shakespeare's plays in the setting for which they were designed.

This project is the brain child and obsession of Sam Wanamaker, American actor and expatriate. Wanamaker was astounded that no attempt had ever been made to reconstruct the theater on its original site. With characteristic American bravado, he dreamt of building not only a theater, but a great center for Shakespearean studies and learning. He has spent the last eighteen years making his dream a reality.

Design Concept and Process

This was a tremendously exciting chance to rethink what a museum is and should be. As a multimedia designer, I had worked within the limitations of the computer workstation. The Globe project was a challenge to break out of the computer box into a sensually alive three-dimensional environment, and to integrate the newest technology and its machines into a historical decor. Here, technology might engender a new kind of space, one that dissolved traditional boundaries between education, exhibits, information, and research.

Adapting such technology to a Shakespearean museum was not easy. My background had been in working with interactive educational programs such as the Shakespeare Project, and other programs which assume a quiet and concentrated environment such as a study or classroom, where one or two people sit facing computer and video screens. Such designs would be lost in the crowded, swirling, public spaces of a museum. On the other hand, aggressively modern, spanky-new technology would be terribly jarring in the elegant Renaissance space architect Theo Crosby was planning. He had devised for the visitor a stroll through a miniaturized Elizabethan England of great variety and charm, with the highest degree of accuracy and attention to detail that modern scholarship could provide. With this emphasis on historical accuracy and the exact theatrical conditions that shaped Shakespeare's craft the task was to exploit a wide range of technical options without overwhelming the delicate atmosphere. Thus in 1988 the ISGC asked me to advise them on how modern computer and multimedia interactive technologies might be used in the museum. As the full complexity of their task became apparent, the museum's designers began to realize that the best way to present the past would involve innovative technologies of today.

I believed it would be possible to create a museum environment that blurs such categories as exhibit and user, past and present, entertainment and education. My goals were the following:

Create a magical junction of time and space

In thinking about what distinguished this museum from others I realized that though the museum does not own any genuine Renaissance artifacts, it does have one great strength: it occupies the actual site of the Globe theater. Here, four centuries ago, Shakespeare's plays were performed; now, the visitor stands beneath a reconstruction of that same theater.

This wonderful junction of time and space, of the old and the new Globe, of 17th century London and the contemporary city looming across the river, should resonate for visitors.

Somehow they should realize," I am standing in London on the actual place where Shakespeare created his plays! All is the same, and yet all is different." Perhaps, here, technology could help.

As the museum is underground, the visitors enter through a lobby at street-level before descending via stairs to the museum level. Why not make this entry way a descent into the past?

Let visitors enter in a hall with large windows through which they can see the view of contemporary London: the Thames, St. Paul's, the modern skyline, firmly reminding them of the presence of the modern city. As they descend the stairway, the windows turn into window-like film projections, featuring the same view of London from the Globe but now going back in time. For example, at the first turning they view Edwardian London, at the next Victorian London, and so on. When they reach the floor of the museum proper, and the exhibits of 17th Century England, the windows show them Renaissance London. They are still in London, but have moved miraculously backward in time and space.

Now build on this experience with interactive displays that help our visitors to identify with the Elizabethans who, as they are now doing, also made a journey to the Globe. On the wall, our visitors see filmed projections of Londoners travelling to the theater: rich burgers arriving in coaches, apprentices ambling over the London Bridge, noblemen in ferries being rowed over the Thames. Large electronic maps trace the various routes. Visitors can press buttons to choose a type of theatergoer -noble or worker- and watch each route light up on the wall, and perhaps see a short film of the home and the neighborhood from which they journey. Workstations scattered about could supply more detailed information about the sociology of London; its neighborhoods, its class distinctions, its transportation technology.

This melange of real objects, simulations, and workstations seems to me a powerful way to transform the uses of space, to make the experience of the space itself functional - guiding, teaching, and entertaining.

Exploit the experience of space

This entry hall design illustrates a fundamental difference between computer and museum exhibits. In a computer workstation all of the information and functionality is stored in one place. The designer's chief task is to provide clear and simple guidelines to help the user navigate through the system, and to help users explore subject matter in ever-increasing complexity.

By contrast, in a museum, information is deployed spatially: the visitor's experience is not intensive but extensive, and the visitor's impressions accumulate as she/he wanders through the space.

This means that in a museum we introduce a subject or piece of information, then repeat, enlarge, or deepen the information as the visitor moves along. Just as in the entry area, throughout the museum the visitor might first encounter information in a large wall display, then explore some facet of the subject in a small workstation, then play with the information in an interactive exhibit.

So, for example, this notion of the junction of time and space can now be repeated and extended in small-scale playful workstations, such as the "Fly Over London" workstation. Facing a small screen, the visitor chooses a century; a film of London in that period seen from the air appears on the monitor. By moving a joy stick, the visitor seems to 'fly' over the city at will. At certain points she or he can 'descend' and enter a site or building. Clicking, for example, on the dome of St. Paul's will result in a film about the building appearing on the screen. The visitor can choose another century, and see the same scene altered by time. The visitor's sense of the mystery of time and history is deepened. London becomes a palimpsest of places and forms stacked on one another, the past informing the present and the present, the past. Thus we achieve the magic of place, of change within continuity.

Get Programs out of "Boxes"

Forget the passive, machine-dominated computer workstation. Instead, find formats that suit the public, sensual, and tactile world of the museum. For example: playful visitor-participation exhibits, such as the "Act In Shakespeare" I described above, where the computer is totally invisible; large-scale wall and room installations that mix three-dimensional constructions with overpowering images to dramatically illustrate subjects such as Renaissance world-views; "magic boxes," where hidden projectors help transform ordinary objects in surprising ways.

Mix styles

While keeping the planned authentic recreations as the heart of the museum, why not create surrounding areas in distinctive and contrasting styles? Such "islands" of contemporary space would add drama, surprise, and focus. In them we could play with scale, color, texture, without worrying about the restraints imposed by strictly Elizabethan style.

The exit area, for example, could feature eye-catching multimedia and electronic displays. Moving upwards out of the museum you would also move forward in time, from the Renaissance to the present, through twisting tunnel-like spaces that dramatically present the history of Shakespearean productions through a mix of large-scale film projections, paintings, sculpture, recordings, texts, and real objects such as costumes.

Even standard 'utility' areas could be made quite exciting with imaginative use of technology. The activities space, intended for lectures and group projects, could be enlivened with an immense interactive wall with multiple display screens. In the research area, scholars could work directly with filmed performances on special multimedia editing stations. Students might receive electronic design kits to create their own sets. Visitors could enter information about their home-town Shakespeare groups into a common database in the shop area.

Depend Upon Collaboration

People find it strange that someone with my background in theater should work with computers. But computer design is very like directing a production; both the director's and the computer designer's task is to coordinate details of design, technology, movement, and artistic interpretation to create a unified whole that guides, teaches, and entertains. It is a quintessential collaborative task. The director depends on the talents of many.

Working on the museum design was even more like theatrical collaboration, for the museum is like a staged performance that has to endure for many years. Accordingly, I sought the help of The Apple Multimedia Lab in San Francisco. Kristina Hooper, the adventurous head of the Lab, invited me to work with a team of her bright young people such as Rob Semper, then acting head of The Exploratorium, and Michael Naimark, a pioneer in the field of interactive film, to devise a set of prototypes for the museum. It was splendid to collaborate with people at the Multimedia Lab. Both the lab and its personnel were rich mines of information about museum and interactive film installations.

At the Globe, I worked mainly with chief of research Andrew Gurr, who was responsible for the scholarly accuracy of the design, and with architect Theo Crosby. Theo, on whose shoulders rests the final responsibility for the entire complex, functioned as a benign but severe critic, forcing the groups' plans into the procrustean bed of consistency and practicality. He had a strong vision of what the museum needs to look and feel like, and a firm grip on such considerations as ventilation, crowd control, and lavatory-access that are often fatal to my high-flown ideas.

Spaces and Exhibits

Within the context of these four goals numerous design concepts emerged. I felt that the exhibits should change and vary in conformance to the style and function of the varied spaces of the museum. Following are some of the ideas that were proposed.

The Main Space

Within the main traditional space, we could "sneak in" discreet interactive exhibits, disguised as closets and tables and statues. These exhibits will be hidden in cabinets or under furniture, and only the guides will know where they are and how to activate them. For example, a display of an Elizabethan dining can become interactive. The guide begins by asking the group whose dinner they would like to see: the king's the merchant's, the apprentice's, the yeoman's? When they have chosen, she lifts the cover from a plate and, lo and behold, the appropriate food appears. The trick is simple, a projector is hidden directly underneath the plate and connected to a computer. When the guide presses a hidden button, a computer program finds the appropriate visual images on a video disc, and projects them onto the plate from below.

Such exhibits also allow the guides to sensitively respond to the daily visiting conditions. When the museum is full and people need to be moved through as quickly as possible, the guide does not alert the group to the presence of the interactive exhibits.

Large-Scale Theatrical Pieces

From the discreet guide activated exhibit we move to the other extreme, exhibits whose whole point is their eye-catching and hopefully show-stopping visibility. For a section on Renaissance world images, I designed a huge electronic skyscape, stretching over three dimensional rooftops. The sky will be interactive: when the guide turns a renaissance model of the universe, the stars in the sky are replaced by images of the heavens current in the period, Ptolmeiac or Copernican, Platonic or Kabbalistic, providing the audience with a graphic display of the variety and imaginative versatility of 17th century cosmology.

Similarly, a wall screen will feature a changing flow of images of woman and man drawn from Shakespeare's plays: mankind as angel and devil, courtier and saint, cowering under the approach of death or striding across the furthest reaches of the cosmos. These images will be accompanied by recordings of illustrative quotes from the plays, such as Hamlet's "What a piece of work is man." A nearby workstation can offer more detailed information on the source and implications of these images in Shakespeare.

Playspaces

Certain areas will be frankly playful. The 'Performance Playground' will be a kind of open, carnival space, a lively unstructured area with game-like interactive exhibits centering on theatrical performance. After earnestly studying the densely detailed sections featuring London and court life, visitors can here relax and "fool around." For example, visitors choose a costume from a large archive and then see themselves dressed in it. They design lighting for a scene on a simulated stage, watch scenes done by different artists, wander through an multimedia gallery of great actors and performances. (The "Act In a Shakespeare Scene" exhibit would be in this section.)

In another such area, "Backstage Alley," designed to present the working life of the Globe, visitors will look through peepholes at actors making-up, at props and scenery being built, at rehearsals. They will be able to see the theater from the actors' point-of-view, looking at the audience from the vantage point of the stage. These peepholes, while seeming to give onto deep and wide perspectives, will actually be projections from small monitors controlled by mirrors which give the illusion of deep space.

Small Workstations

Small, stand-alone workstations will be scattered throughout to give information on specific and limited topics, preventing visitors from spending too much time in one place.

Some workstations might focus on scholarly and conceptual problems. For example, the final shape of the reconstructed Globe reflects a series of speculative choices about the original theater, its architecture, decoration, and staging practices. Almost every choice could have been different, eighteen sides instead of twenty-four, fake marble instead of hangings,and so on.

"Design the Globe" is a workstation that allows visitors to deconstruct the theater in order to comprehend the process of choice and decision that led the designers to this particular shape.

Visitors choose from a list of the major choices facing the designers: the shape of the theater, the shape of the stage, the decorations, facade of the 'tiring house,' etc. For each choice, they can browse through the evidence available to scholars, then choose an option. Bit by bit, they build up their version of the Globe. Then they can place scenes on the stage they have created and compare it to the way the same scenes look in the reconstructed Globe above their heads.

For another workstation, we filmed Andrew Gurr talking with his usual urbanity about Shakespearean history and theater. Using this footage, we created "Ask the Globe." On the video screen people can browse over detailed drawings of the exterior and interior of the Globe. If a visitor sees any detail that interests or puzzles him, he clicks on it with the mouse. A film of Andrew appears in the upper corner of the screen and chats interestingly about the detail. If they have selected the picture of a woman in the audience, for example, they will learn that she can be identified as a merchant's wife by her dress and companions. Andrew then will go on to discuss briefly the social and domestic life of such a woman, and if the visitor chooses, will conduct them through a filmed tour of the interior of a bourgeois house.

Activities and Research Area

The activities area would be a large multi-purpose space, which can be re-configured for different uses. Here groups could assemble for special educational programs. Individuals could do research, special exhibits could be mounted, and school children could experiment with designing and performing Shakespeare.

The heart of the space will be a large wall screen capable of projecting images from multiple sources. A lecturer, for example, could show different versions of a play simultaneously, or students could look at stage designs from many sources, choose details from each image and combine them into an integrated image. Then, having thus built up a set for a play, they could perform a scene in front of the wall, which would be recorded on video and which they could take back to their school.

The research area would accommodate serious scholars who want to work with Shakespearean performance. A special editing program, called the Living Variorum, will provide a fully annotated multimedia guide to a play or performance, modelled on the text-based guides that are central to Shakespearean scholarship. Its editing program would allow scholars to view multiple films, photos and text, and to assemble multi-media editions of a play on the computer screen. This program would be connected to a Shakespearean Archive, which would be constantly updated to provide the latest findings of scholars and critics.

Shop and Information

To help visitors assimilate and organize their experience, we might have electronic cards which they could insert in exhibits. Once the visitor leaves an exhibit, the cards can be run through stations in the information area, which inform him where he can get printed information on specific areas of interest.

The shop might also have information kiosks, offering the latest news about productions, ticket and seating availability, plus glimpses of productions, interviews with the casts and sample reviews.

The Design Portfolio

This portfolio is written in MacroMind Interactive Director, a new program that enables one to make color animations fairly quickly. The program can also call up other programs such as Hypercard, and can control a videodisc player. With Interactive Director, I could create an animated interactive simulation of the museum, divided by sections. By clicking on any section the user can travel to that area and look at animations of the different interactive exhibits it contains. By clicking on an animation, the user can go to a working model of the design and actually try out what the exhibit would feel like. In some, as in the "Act In Shakespeare" for example, there is a film showing the model we created.

As the Globe was still in the process of exploring its options and had not yet produced a final design for the museum, I decided not to create finished programs. Instead, I sketched out a large number of ideas, some as working models, some as detailed animations, and some as briefly noted "conceptual" pieces. Thus the Globe could explore a whole range of options before it had to make the hard choices dictated by money, time, visitor usage, and other practical considerations. Most probably, only a small number of the wide range of exhibits I designed will be included in the actual museum. But by designing the whole group of models as an interactive animation program, The Design Portfolio, I gave the Globe a usable resource as well as an exemplary application of interactive multimedia.

Treasures of the Smithsonian

A Museum Orientation You Can Take Home

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Abstract

Treasures of the Smithsonian is one of the first completed applications of the Compact Disc-Interactive (CD-I) format developed by N.V. Philips and scheduled for introduction in September 1991. Treasures received a first place "Muse Award" from the American Association of Museums in May 1991.

The *Treasures* program is not an "orientation" program focusing on where to find collections and objects. Indeed, it was not developed for exhibit installation at all, but rather as a consumer product to be purchased and viewed at home. Rather, *Treasures* provides a "sampling" of the objects one might see over several visits to the Smithsonian museums. In that sense, it might serve as a pre-visit orientation or a post-visit souvenir.

The *Treasures* program presents a sampling of 150 objects from the Smithsonian's 14 museums in high-quality audio-visual presentations, with narration, sound effects, and music. Viewers can select treasures by museum, by date, by thematic tour, or by category. Each treasures include a text Note, giving details about who, what, when, where, materials, dimensions, photo credits, and additional commentary. Each treasure also has "links," allowing viewers to jump from one related treasure to another without using the metaphoric menu scheme. Some treasures have "toys" - special interaction allowing viewers to, say, walk around a sculpture, view a detail of a painting, or hear sounds associated with an instrument or device.

Introduction

Treasures of the Smithsonian is a co-publication of the Smithsonian Institution and American Interactive Media, Inc., a subsidiary of N.V. Philips. Treasures is one of the first completed applications of the Compact Disc-Interactive (CD-I) format. Both the disc and the system were to have been introduced in selected U.S. markets in September of 1991.

The *Treasures* program is not an "orientation" program focusing on where to find collections and objects. Indeed, it was not developed for exhibit installation at all, but rather as a consumer product to be purchased and viewed at home. Treasures provides a "sampling" of the objects one might see over several visits to the Smithsonian museums. In that sense, it might serve as a pre-visit orientation or a post-visit souvenir - but it is meant to interesting enough to be enjoyed by some viewers who may never have a chance to visit.

The focus of the program is neither the location of objects nor the mechanics of moving from one museum to another, but rather on the variety and richness of the Smithsonian's collections as a whole. The "hidden agenda" of the design is to appeal to viewers' interests in one subject area and draw them into new areas. After viewing the program, for example, someone who might have only visited the Air and Space Museum might consider stopping by the Hirshhorn, or the Museum of Natural History, after exploring some of the connections between treasures on the CD-I disc.

Description

The *Treasures* disc offers a sampling of 150 objects from the Smithsonian's 14 museums. Each object is described in an audio-visual segment featuring 2-5 images, 20-45 seconds of audio commentary (with sound effects and/or music), and a detailed text Note displayed at the viewer's discretion. Some treasures also include "toys" - special presentations that, for example, let you walk around a sculpture, scroll over a painting, or "play" an instrument.

Viewers can select treasures by museum, by date, by category (fine arts, technology, etc.), by the names of associated people, from an alphabetical list, or as part of a thematic "tour" of 5-8 objects at a time. Playing all the presentations in a row takes about 2 hours. Adding time for reading Notes and playing with the "toys" brings the total interaction time to over 3 hours.

About 90 Smithsonian staff members contributed to the project, led by Ralph Rinzler, Bob Dierker, and editor Joe Goodwin. Audio scripts are by Smithsonian Magazine columnist Edwards Park.

The disc was designed and produced by Jim Hoekema, assisted by a team including Mike Nibley (editor & line producer), Amy Hough (production assistant), Mark Phinney (audio), Juliana Montfort (photo research), programmer Jon Singer (CapitolVideo), Taylor Made Images (model maker), Michael Gallelli, Lee Moyer, and Shoshonah Dubiner (graphic design & illustration). Ray Ashton was the AIM executive for product development.

Initial design began in the Fall of 1987. Development began in earnest with the hiring of staff in June 1988 and continued for about a year, with all media elements captured and encoded by September 1989. Programming continued for another nine months, and after a hiatus, testing was completed in 1991.

As a "museum orientation" that would appeal to general adult viewers throughout the world, *Treasures* required a design that would combine: (1) the flair of consumer entertainment, (2) the dignity of a venerable cultural institution, (3) an ease of use appropriate to viewers unfamiliar with interactive media, and (4) a sufficient depth of content to make the novelty worthwhile. To achieve these goals, we addressed a number of major design issues - which are in fact present in any interactive multimedia application.

Scope of Content

The Smithsonian Institution includes 14 museums (and a zoo), and their collections total more than 100 million objects! The first issue to be solved for a title like *Treasures of the Smithsonian* was, which ones? Before that could be solved, we had to ask, how many? And how much information should be presented for a typical object?

We quickly realized that the disc would have to be a "sampler" of the Smithsonian holdings. This decision gave us considerable freedom in selecting objects for inclusion. But it also obliged us to treat the selected objects well! If we weren't offering a definitive quantity of material, we had better offer a unique and attractive quality of experience in the program. An apt analogy might be: the smaller the dinner party, the greater the attention you give to each guest!

Presentation Style

Given an arbitrary number of treasures, we resolved to give every treasure its due in audio-visual presentations with the best images we could find, a lively narration with humor when appropriate, and a soundtrack with music and/or sound effects that would reinforce the overall interpretation. As a result, every treasure has its own mini-movie. When viewed together, the presentations offer a wide variety in music, mood, and content.

To achieve high "production values" of the kind people are accustomed to seeing on television, we sought out the highest-quality images (mostly 4x5" color transparencies), researched music and sound effects thoroughly, planned the sequences of images and narration with great care, and took pains to produce a relaxed, intimate narration seamlessly integrated with music and effects. (We mixed in analog formatand then converted to PCM digital audio and converted toCD-I's mid-level "B-stereo" format.)

Personality

Interactive multimedia programs are not databases: true, they present information, but they also reflect an editorial purpose and viewpoint, just like a book, a speech, or a movie. As in other media, interactive programs are more successful when they have a clear point of view, a sense of personality.

To give *Treasures* a point of view, we chose to present commentaries on the objects written by one person: Edwards Park, a professional writer with a monthly column in Smithsonian magazine. In his writing, as in person, Ted combined an irreverent Yankee "show me" skepticism with a strong curiosity about virtually any subject, and a particular enthusiasm for the human story behind every artifact. Ted had no experience in interactive media, but he knew the Smithsonian like the back of his hand. As we put it, there are many different ways to visit a museum or find out what's there, but going with "Uncle Ted" is always a little more fun, because he always has interesting stories to tell or a surprising "take" on a familiar object.

Ease of Use

Consumer titles require a rigorous level of ease of use. The most rigorous definition I know of would be as follows: A program is easy to use if a typical user can begin at any point and, after a couple pokes, pretty much figure it out. "Typical user" means the sort of the person the program was designed for. It's not necessary that every screen contain instructions on all possible actions; the qualifier "pretty much" means we can expect users to have enough exploratory interest to try one or two navigational paths and see what happens.

In the design of Treasures, we tried to achieve this level of obvious ease of use through a number of strategies.

For one, we simplified the hardware user interface through software: while the CD-I player has two "select" buttons, we treated them as one button. (With two buttons, you have to explain the difference somewhere, and users have to remember it. With one button, there's nothing to explain, and a viewer coming in "cold" to the middle of the program is more likely to have a successful experience after only one or two attempts at interaction.)

Icons are easily recognized and distinguished one from another, but they are not always easy to interpret when first seen (especially when they're only 25 pixels high, as on TV systems like CD-I). On the other hand, words (text) are better for explaining a function precisely; however, words all "look alike," and a long row of words across the the screen is boring and unappealing.

For *Treasures*, therefore, we tried to combine the best of both worlds. Standard functions appear as icons in the normal state; when the cursor "points" to an icon, it changes to a word describing the function. This change thus explains the icon at the time it is needed, while simultaneously confirming that the program knows where the user in pointing.

In other contexts, where the "hot spots" are not buttons but objects in a metaphoric room, the same technique is used: objects identify the function or pathway they represent in words when the user points the cursor at them.

Other aspects of the Treasures design promoting ease of use include the following arrangements:

- After you select anything from a menu by name (a museum, for example, or a treasure), you go to a screen with that name displayed prominently (so you know the program got it right).
- Viewers can interrupt any audio-visual sequence, then resume it, start it over, or skip to the end. (In my opinion, all audio-visual programs should have this feature.)
- All treasure presentations follow an identical format, so that viewing one or two treasures yields reliable expectations about all others. (The only exception is the "More" function, described below, available for only about 25% of the treasures.)

Depth of Content

Obviously, an interactive program should be easy to use. But it should be *worth using* as well! To be appealing as an interactive program, truly different from other forms of entertainment, a consumer multimedia title must be *significantly* interactive.

In the case of *Treasures*, there was a need for more depth, so that individuals who found an object particularly interesting could pursue their interest farther, without forcing that level of detail on all viewers. Our solution involved (1) adding more detailed information for every treasure, and (2) adding special features that were available only for some objects.

For all treasures, we added a scrolling text field called "Notes," which contained an extended caption, giving the who, what, when, where, materials, dimensions, etc. for every object, as well as an additional sentence or two of written comments. If the audio commentary was essentially a light-hearted, passing comment on the object, the text note could go into more detail, or make a point not mentioned in the soundtrack.

For some treasures - only about 25% as it turned out (we had hoped for more) - viewers can select an icon labeled "More." The "More" presentations are not simply additional audio-visual segments; rather, they offer some way of interacting with the object under a higher degree of user control. They let the viewer "play" with the object in someway. We called them "toys" (a term devised by Larry Lowe, who suggested the feature).

For example, the toy for a work of sculpture lets you "walk around" the work by moving a slider bar from left to right, which takes you through a half-dozen views of the work. For a painting or other piece of "flat art" such wallpaper or a quilt, you can scroll left and right on a close-up view of the work. For some paintings, a slider takes closer andcloser to a tiny detail. On two or three works, the toy lets you point to a scene or a figure in a group portrait in order to have the subject identified verbally.

Sometimes the toys are aural instead of visual. For the Telegraph Key, you can click on a letter of the alphabet and hear the Morse Code symbol for that letter. For some musical instruments (the Servais Cello and the Appalachian Dulcimer), you can hear a complete composition played on that instrument. For the African Thumb Piano, you can "play" the instrument in simulated form by pointing and clicking on the piano's protruding prongs.

These types of interactions complement the standard audio-visual presentations by offering more direct user control, adding an appealing element of discovery and playfulness. In effect, the "toys" are additional "layer" of content.

Visualizing Navigation

A metaphor is like an extended figure of speech, rendered visually. It works by saying, in effect, "Moving through this program is like moving through an environment like this." In the case of *Treasures*, we struggled with one major structural problem, along with the general question of what sort of visual style would be appropriate for the Smithsonian.

The structure of the program allows users to select treasures by different means: they can look up a treasure by date, by museum, by name, by category, or by the person who was associated with the object. These methods were essentially designed for looking up a single treasure. In addition, however, we wanted to offer "tours," groups of 4-8 treasures united by a common theme or pretext. Thus, we needed to represent two kinds of choices (single-object lookups and multiple-object "tours") from the same main menu.

Much thought was given to the appropriate metaphor and "look" for the Smithsonian. An architectural theme seemed obvious for an institution comprising 14 museums and a zoo, although even this decision was not unanimous among AIM executives. In the end, we retained the architectural theme with objects representing pathways: a map for choosing by museum, a tree-stump for choosing by date, a file cabinet (by category), a bust (by person), and posters for tours. This space was created in a model (at a 12:1 scale), lit with stage lighting techniques (spots, fills, masks, etc.), then shot in16mm film, transferred to videotape, and then captured and encoded into CD-I formats.

The model strikes an appropriate balance between realism and abstraction. The objects are obviously not real when you get close up (which helps viewers see them as symbolic), yet the realistic surfaces and dramatic lighting - in a large public space obviously intended for display, with a few enigmatic objects lying about - evokes the combination of grandeur and mustiness associated with "the nation's attic," as the Smithsonian is often called. The visual theme of masonry surfaces reappeared in control panels and menus throughout the program.

When One Interactive System is not Enough

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The Art Institute of Chicago's pioneering development of public computer programs jump started with two fortuitous events. In 1987 the museum was asked to join a consortium of museum education directors from seven art museums whose main goal was to research and experiment with educational computer technology. Soon afterwards, the Art Institute became one of sixteen American institutions selected to receive an Apple Macintosh computer, Sony videodisc player and monitor from the Agnelli Foundation of Italy with a single requirement: that the equipment must be available in a public space with the Agnelli videodisc of Italianculture. Dr. Kent Lydecker, then executive director of museum education at the Art Institute, eagerly accepted both the consortium membership and equipment, envisioning that the proverbial cart and horse were, for once, arriving at the same time.

Through involvement in the Museum Education Consortium Art Institute staff - including myself, Alan Newman director of imaging and technical services, Robert Eskridge, associate director of school programs, as well as Dr. Lydecker - became well-versed in the vocabulary and practice of many different kinds of multimedia products. Most of these fell into expensive, high-end equipment categories such as HD Television and digital color reproduction. As a result, the prototype visitor program produced by the consortium required three years of development, six-figure grants and non-standard equipment - all characteristics of ground-breaking, research-oriented projects.

At the same time, the Art Institute's immediate goal was to initiate in-house production of educational programs with existing equipment and little funding. Through the museum's affiliation with the renowned School of the Art Institute, I was able to enroll in a HyperCard course and befriended many art students who were interested in using their programming and graphics skills for the benefit of the education department. The museum's first interactive program was a HyperCard stack created with the help of two such students. Based on Andy Warhol's factory building, complete with studio, gallery and party floors, the program was made available in an educational space which itself had been converted into a Warhol Factory with art-making activities for families in conjunction with the Warhol retrospective on view in the summer of 1989. This experimental product was very well-received by museum staff and visitors alike, and is now in the hands of the nascent Andy Warhol Museum, based here in Pittsburgh.

The ease with which the Warhol stack proved to be asuccessful experiment encouraged the department to apply for a National Endowment for the Arts Museum Programs grant of $10,000 to develop similar stacks based on our permanent collection. Eight Art contacts programs based on eight different museum collections have resulted after almost two years' work by fifteen designers, none of whom were professional graphic artists or HyperCard hackers. Working in teams under my directorship, they researched their topics, which ranged from African art to Chicago architecture, and met once a month to share discoveries, problems and solutions. Their imaginative stacks will be available in the museum's educational center opening in May,1992, as well as distributed free to Chicago area school teachers for use in their classrooms, preferrably before or after field trips to the Art Institute.

At the same time that the Art Institute was developing these Art contacts stacks in 1990-91, it was involved in a videodisc project with The Voyager Company. Partially funded by the Markle Foundation, the project's special task was to create an interactive program that would teach children as young as four years old how to look at art. The reputation of The Voyager company for high quality, innovative computer products and the unique challenge of this project made Dr. Lydecker, Mr. Newman and me eager to explore the possiblities.

The result of this team effort has been a lively exploration of 300 objects selected from all aspects of the museum's collections, preserved on videodisc and displayed on a televsion monitor. Information is also given through voice, music, sound, or poetry that accompany each object and offer clues to its meaning, origin, or nature. The complete program, consisting of a videodisc and a HyperCard stack, will be commercially available through the-Voyager Company and the Art Institute's Museum shop, as well as for public use in the education center of the museum.

The reasons for producing this variety of multimedia products are many. First: an intuitive fear shared by members of the Museum Education Consortium that if museums did not set the art history and educational standards of these products, videogame companies and other commercial firms with little or no art experience would flood the market first, leaving little space for independent, better qualified products. Unfortunately, some of this fear has already been justified, as evidenced at the Getty conference on Arts, Education, Technology held earlier this year in Los Angeles.

This is not to say that there is no place for commercial firms in this multimedia arena. After all, the work with The Voyager Company has produced, as others have indicated, a model interactive educational product. However, such a firm must be committed to consulting those institutions whose specific talents lie in educating the public on a given topic and deferring to their content advice when disagreement arises.

The second reason for entering this arena is that the Art Institute recognizes the importance of computer-based learning as a vital educational tool because the nature of the museum audience is so diverse. Novice visitors, art scholars, school children and their teachers all visit our museum every day for very different reasons. Each group needs different information presented in different ways which we have attempted to address with our multi-level approach to hypermedia. For example, the novice visitor might find the free exploration of the videodisc program an entertaining, non-threatening way to learn more about art. Similarly, the more didactic Artcontacts programs are designed for classroom instruction.

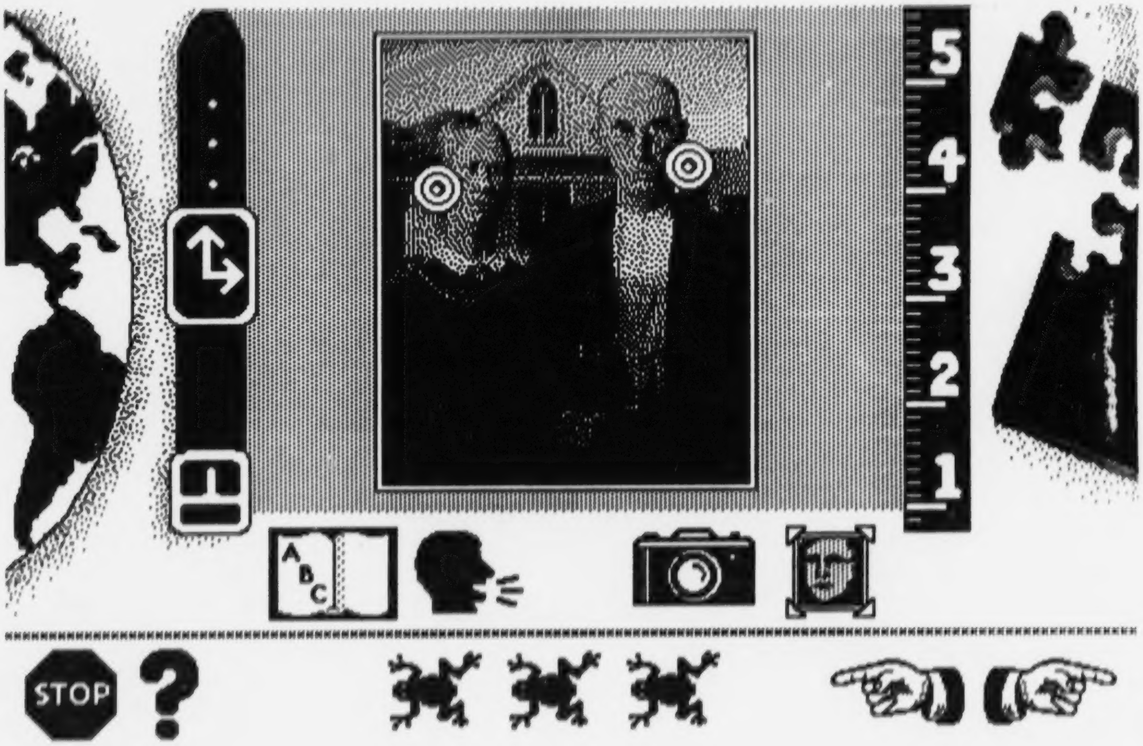
With regards to distributing hypermedia products outside the museum walls, additional attention must be paid to the various economic backgrounds of the museum audience. Our videodisc computer program will be marketed to those individuals who already have videodisc players and Apple computers at home, but its target audiences are institutions such as schools and libraries whose budgets include purchasing and maintaining this equipment. Within the K-12 school systems, however, many only have donated equipment, which informal studies show, are usually stand-alone Apple computers accompanied by very little funding for software purchase. Therefore to be able to receive free quality programs, such as Artcontacts, is essential for many schools in order for them to integrate computers in their classroom effectively.

Finally, of all the subjects pertaining to museum education, probably the most hotly debated is the questionof how visitors learn. Museum educators spend entire careers studying visitors' learning styles. The most talented lecturers are able to read the learning levels of an audience by watching behavior, listening to questions, and monitoring physical and verbal responses. However, only a small portion of museum visitors attend these live-action educational programs. As a result, there is very little direct knowledge about how most visitors understand, learn, or respond to the information on display in the museum.

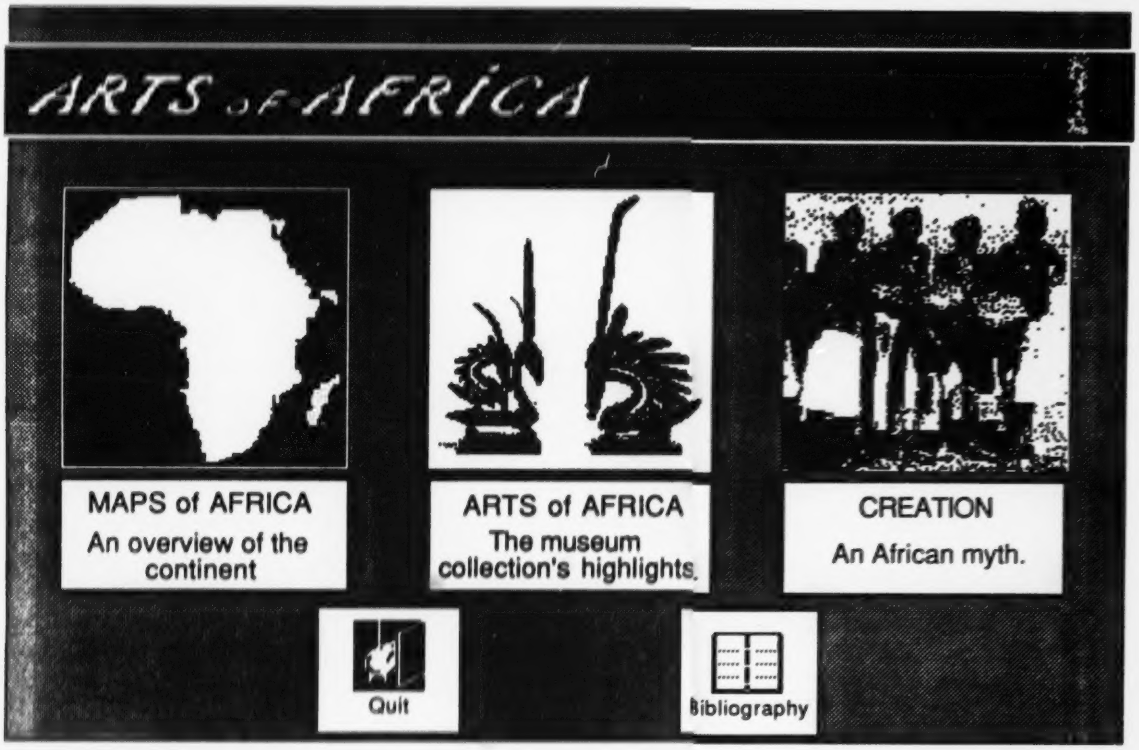
Of course there are several good theories about how museum visitors learn, most of which are based on traditional learning models developed by pioneer educators who used classrooms, not museums, as their behavioral laboratories. If we take just one learning theory, for example Howard Gardner's theory of multiple intelligences, we find some interesting correlations between personality and computer ability. Gardner proposes that we all are born with the ability to develop as many as seven kinds of intelligence, including linguistic, logical-mathematical, spatial, musical, kinesthetic, interpersonal (the need to work on one's own), and intrapersonal (the need to work in agroup).

Because interactive technologies are able to deliver information in a variety of formats according to a user's multiple learning styles, the educator is no longer posed with the question of what is the SINGLE learning style of its audience. Programmed appropriately, computers used in museum settings have a unique opportunity for accomodating an individual's learning preferences, as well as developing those which appear to be recessive. In other words, the first time a logical, linguistic type person uses the museum's videodisc program, he may chose to work alone, look at the details, hear the title and artist and see how large the objects are. After a few sessions however, he might be more interested in the relationship of the music to the objects, locate them on the map and encourage others to join with him.

In closing, a word of advice to those museum professionals who are considering a jump into the multimedia world. No matter how seductive the equipment and its increasingly sophisticated software, never lose sight of your ultimate reason for developing these projects: to make yourcollections more accessible to the public. If a program is too complex, too expensive, and too time-consuming to make and use, it is not serving the best interest of your audience, a precious museum resource.



Sample computer screen from AIC-Voyager videodisc project displaying Grant Wood's painting, American Gothic.


ARTS of AFRICA
MAPS of AFRICA
An overview of the continent
ARTS of AFRICA
The museum collection's highlights.
CREATION
An African myth.
Quit
Bibliography

Sample computer screen from "Arts of Africa" Artcontacts program, designed by Pierre Archambault and Gian-Luca Ferme for the Art Institute of Chicago.

Taking the British Golf Museum Home

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Over the last two and half years, I have been in the unique position helping to create CD-I discs while at the same time, I was the first end-user of CD-I in the United Kingdom. From the onset, it was always our intention to make a consumer disc as well as the museum discs, but it was a secondary consideration. Our first objective was to finish and open the British Golf Museum and then take things from there.

On the surface, it might appear that a disc or discs for use within a museum require a very different treatment than one designed for home use; but as we all know, appearances can be deceptive.

The British Golf Museum, which opened in June 1990, tells the story of the development of British golf from the middle ages to the present day. Golf is a game of motion and yet for security and conservation reasons, all the objects in the museum must be kept behind glass. Museums as a whole are often perceived as dreary places with rows and rows of objects on display with either very little or too much interpretation. This perception dates back to the origins of many museums in the late 19th and early 20th centuries when visitors could be amazed by seeing a wide variety of strange and exotic objects that they had never seen before. Hence the stack 'em deep, pile 'em high philosophy of display. With the advent of film and then TV, people became accustomed to seeing these wondrous objects in the comfort of a cinema and then in their own home. Museums needed to change - to find new ways to amaze the visitor.

The use of audio-visual material is one the tools available to museums to help add an extra dimension to their displays. In the British Golf Museum, we have used laservision and CD-I technology to generate our audio-visual material. And it is this audio- visual material that allows us to amaze our visitors. Yet the touchscreens that we use are not toys or gimmicks; they convey a great deal of historical information that is fundamental to an understanding of the history of British golf. They are designed to complement the displays of objects and they then convey their information in an interesting and exciting manner.

Altogether, we have 11 touchscreens, 8 of which use laservision players and 3 of which use CD-I. In addition we have an audio- visual theatre, which uses a laservision player; five tableau commentaries that also run off of laservision players and finally there is one slide show. Before I go any further, let me stress that I am one of the least technically minded people you will ever meet. When I was at school, I was told by my physics teacher that the only practical experiment I ever got right was the result of mathematical co-incidence and not the product of sound methodology. I don't know how to physically make a disc, or indeed even how to program software. My role in the development of the museum discs was as a writer in the old fashioned sense of the word. I wrote the words that formed the scripts and I specified what pictures were to be used where in each script. Ted Toms of the APS Group was responsible for producing all the programs and Philips Interactive Media Systems provided the technology.

When Ted and I started on the project, we quickly realised that the limitations on what we wanted to achieve were the constraints of the museum environment and not those of the technology. The challenge was actually how to harness the immense capabilities of the technology within the very restricting museum environment.

First, the touchscreens had to be integrated into the museum so that they contributed to the overall story being told and interpreted within the building. The museum is set out chronologically and divided into 15 galleries. Each gallery has a well defined theme and each display within the gallery contributes to that theme. It was decided that each touchscreen would only contain programs that dealt with the specific gallery in which it was located. In other words, the touchscreen that is in the gallery about the Open Championship 1860 through 1891 only contains programs about that subject within those dates. In all, the 11 touchscreens were divided between 7 galleries.

All the research and writing of the museum a/vs were done in conjunction with the setting up of the museum itself. The touchscreen material was totally integrated with the museum displays. Being a typical historian, I wrote everything in chronological order for the museum. The material for the touchscreens went hand in glove with the museum text panels and captions. I tried to avoid duplicating information between the touchscreens and the museum text. In fact, if you looked closely, you would find that the introduction a/v for each touchscreen often continued the story told on the introductory text panels for each gallery.

All the copyrights were cleared for use in the museum only. As I said, we knew that we would eventually do a consumer disc, but we concentrated on getting the museum open to begin with, and work on the consumer disc itself did not start in earnest until about 4 months after the museum opened. This meant that clearances for material used on the consumer disc were obtained separately. I did not want to cloud the issue before the museum itself was up and running.

From a content point of view, each program, or a/v, had to not only be historically accurate and be totally integrated with the display material that surrounded it, but it had to be good television at the same time. One of my obsessions in life is that something can be both accurate and entertaining. Thus whenever possible, any biography or account of a dramatic match had to have a good hook in the story or anecdote in it. I also had to be able to illustrate any program. This caused a few problems for the period between 1860 and about 1891 when golfing photographs are few and far between.

From a visitors point of view, each touchscreen had to be extremely user friendly. To be successful, they had to be easy to use by visitors of widely diverging ages, all of whom are literally just passing by. The programs needed to be short and easy to access. This is a key part of the museum environment. We have to entice visitors to use the touchscreens; we couldn't have something that was overly complicated to use. It had to be kept simple. One of the jobs that I had a long time ago was that of a Training Manager for a Los Angeles department store. My primary function was to teach new staff how to use the point of sale terminals. The biggest problem I had, especially in older employees, was to overcome a syndrome I called "Terminal Paranoia", which manifested itself as an uncontrollable fear that by pressing a wrong button, the cash drawer would fly open and a pair of hands would spring out and start throttling the unsuspecting employee. The same syndrome exists in a museum. Our visitors haven't just bought some new hardware and software which they can't wait to try out. They have walked in off the street to either learn about the history of golf or to get out of the rain. And now they are confronted with a strange little monitor flashing the seductive message "To start the programme, touch the screen". At this point, we probably have about 10 seconds to gain their interest and their trust.

Simplicity is the name of the game and gaining the visitors trust is essential. We - that is Ted and I - felt that the key to doing this lay in the menu construction. We decided that the visitor using a touchscreen should not have to go deeper than a main menu and one sub-menu to access a program and that they must be able to stop a program at any time and return to the main menu either directly or via one sub-menu. This is all well signposted on the screen.

We also decided that any menu should be limited to one screen only. With the format that we used, the maximum number of choices that could fit onto one screen was 10 and that set the ceiling on the number of choices. We felt that it was important to use the same format of menu display wherever possible to breed familiarity, and in our museum, familiarity breeds contentedness. We must be doing something right, because 85% of our visitors think that the touchscreen instructions are excellent or very good. And the number of finger prints that we have to clean off all the screens every day show that all the workstations are well used.

The length of the a/vs was also a prime consideration. As you undoubtedly know, most museum visitors have a remarkably short concentration span. On average, they only spend something like 5 seconds reading a text panel. The time spent watching an a/v is deceptive. When I went to one museum to look at their use of touchscreens, I thought that the a/vs were lasting about 3 minutes. Then I started to time them and they were actually lasting between 70 and 90 seconds.

I aimed to keep all of ours at about 60 seconds - my simple guideline was that no script could be more than a single page of double spaced A4 paper. If it was longer, something got cut out. But just to prove that nobody is perfect, I eventually discovered that professional actors read more slowly than museum directors - so most of the a/vs are actually about 70 seconds long.

About 75% of the touchscreen programs are a/vs, they rest are text, usually in the form of statistics and there are two touchscreens that are quizzes.

It is not a coincidence that as the visitor moves through the museum, the a/vs become more sophisticated. Because the touchscreens are set out chronologically, the type of visual source material to illustrate them with is constantly changing. In the early periods, we are limited to very basic black and white photography, that gradually becomes less stiff and formal. Our earliest moving image dates from 1908 and many of the inter-war period a/vs are sourced from film and the postwar ones, from colour video.

All the touchscreens are powered from a central control room. This was another conscious decision. It allows us to make repairs etc without interfering with the visitors who are going through the museum.

As many of you are aware, there is a fundamental paradox when using interactive technology within a museum or indeed any tourist attraction. A touchscreen can only be used by one visitor at a time and the actual screens are quite small. So, how does one reconcile this one-on-one individual experience with the need to have a large throughput of visitors, especially in the summer season; how does one ensure that all the visitors feel that they have got their money's worth when only a small percentage will actually be able to use the interactive displays themselves?

There is no direct solution to this problem, but there are a few ways to get around it. The first is the use of large slave monitors suspended above the touchscreens. This allows groups of visitors to view the program and most seem quite happy to watch a/vs that somebody else has activated.

The second is the fact that the touchscreens are spread throughout the museum. This allows visitors to move from one to another in the happy hope that they will eventually get to one that they can use themselves.

Altogether, there are well over 2 hours worth of programs in the museum. We don't use up the capacity of any of the 11 discs and we could have theoretically condensed the number of touchscreens but to do so would have lost all the advantages of ease of use and menu design that I have been talking about and it would not have worked nearly so well given the strong narrative layout of the museum.

I must just mention our two quizzes. One is on the rules of golf and the other is on the history of golf. They offer 9 text questions at any time from a pool of 50. I will tell you now that if any of you visit the museum, there is an easy way to impress your friends by getting 9 out of 9 on the history quiz. All you have to do is to make sure that you read the 69 text panels and 1,000 captions in the museum plus work your way through the 138 touchscreen programs.

Oh yes, there is a second way - you can buy the CD-I disc of the British Golf Museum. Work, or play, your way through that and you'll ace the museum quiz every time.

This segues neatly into the second part of my paper, the development of a CD-I disc for the consumer market that is largely based on the a/vs developed for the museum. This disc uses the same basic pool of information that the programs developed for the museum used and indeed, many of the same a/vs.

But when it comes to a disc for the consumer market, you can completely forget everything I've just been talking about. Museums are about education - home products are about entertainment. On the surface, these two concepts may appear to be mutually exclusive - but they aren't. They just need to be repackaged.

The museum discs are simple and spartan. The information on them is spread across 11 individual discs. Not all of what is on the museum discs is on the consumer disc and vice-versa but in essence one is talking about telescoping 11 discs onto 1. This requires completely different concepts of menu design. The technology is king in the home - the key is to find the best way of using it. There are not the constraints of the museum environment. Whereas the prime consideration with the museum discs was that they be easy to use, the object with the consumer disc was to make it fun to use.

When looking at adapting the museum discs for home consumption, there was another vital factor that had to be taken into account. The museum discs were designed to be seen in a museum and used in conjunction with the historical objects that surround the touchscreen workstations. Using the museum discs is a three-dimensional experience. The consumer disc needs to stand alone. It is a two-dimensional experience. It needed something to compensate for the third dimension, and that something is pure entertainment. But as I said earlier, something can be historically accurate and entertaining at the same time. I believe that we have achieved this happy marriage of entertainment and accuracy on the consumer disc.

The consumer disc is divided into three unequal parts. The first and largest part is the history of British golf from 1457 to 1940. The second is a quiz and the third is a game. Wait a minute - didn't I already say that there are two quizzes in the museum? But remember how I described them - nine text questions from a base of 50. The consumer quiz uses text, sight and sound and operates from a base pool of 500 questions. It is a lot tougher than the museum history quiz. I should know, I wrote them both. Again, the consumer quiz is dressed up in order to entertain. Not only is there the trivia pursuit element to the quiz, but the format is designed for maximum fun - you are actually playing a round of golf on the world famous Old Course, which, for non-golfers in the audience, is in St. Andrews, and the speed and accuracy with which you answer the questions determines your golf score. All the answers for the quiz are contained within the history section of the disc. Like I keep saying - you can be historically accurate and entertaining at the same time.

The golf game is again designed for maximum fun. It takes the form of a sudden death playoff on the Old Course, and by using animation, you choose an historical figure for your player and you have a choice of historical equipment to use as clubs and balls. The history section of the disc can't tell you how to play the Old Course, but it does tell you about the characters you are choosing and will give you insight into the type of ball and clubs to use.

On the menu design for this disc, we wanted to get away from the simple menu structure used in the museum. Instead of a screen with a number of choices on it, the menu scrolls from left to right and back again. This makes it fun to use and gives a feeling of wandering through time. In the museum, time is against you but at home, time is on your side. As one would expect with CD-I, the menus not only allow you to scroll to the main subjects, but also to form links with items of a like nature. The menus actually correspond to the chronological layout of the museum so that you have the ability to go through the disc as if going through the museum and then like a second visit to the museum, you can go directly to the parts that interested you the most.

The historical section of the disc required a certain amount of modification for home use. As I said earlier, the museum discs were integrated into the fabric of the displays. In the museum, we cover the period from 1457 to 1860 with artifacts, tableaus and documents on display in the galleries and the discs only start in 1860. Furthermore, all club and ball development throughout the museum is interpreted by the objects themselves and we did not do any a/vs on that subject. On their own, the museum a/vs would not tell the complete story, so I needed to write about 30 new scripts to fill in the gaps in the historical section.

As noted earlier, all copyright clearances for the consumer disc were dealt with separately from the material used in the museum.

As with the museum discs, all design work for the consumer disc was done by Ted Toms at APS. My role on the home disc was limited to being the historical adviser and writing any necessary new historical scripts plus the quiz.

I sincerely believe that the consumer disc offers the purchaser a complete armchair golf experience - the rich history of British golf plus a quiz and a game set on the world's most famous golf course. In a sense, there are two ways of taking the British Golf Museum home with you. The first is to try and break into our building and steal something from it. I don't recommend that option - we have a very, very, very good security system. The second and much easier way is to buy the consumer disc of the British Golf Museum. In either event, there is no substitute for visiting our museum and seeing everything I've been talking about first hand.

As I said at the beginning, I am an historian by training and there is a school of thought that maintains that the pattern of history repeats itself, so it may be of some interest that I am not the first member of the Lewis family to be involved with the birth of a new technology. In 1925, my grandfather, Albert Lewis produced and directed a very successful Broadway musical call The Jazz Singer and he sold the film rights for it to Warner Brothers. The brothers Warner decided to make The Jazz Singer as the first talking picture, which they did in 1927, starring Al Jolson. Jolson was not the first choice to play the lead. George Jessel, who had played the part on Broadway, was. But when Jessel heard that it was going to be a talking picture, he held out for more money. Jolson took the part for no money. Instead, he took stock in Warner Brothers. As a result of appearing in that movie, he became a legend and his stock in Warner Brothers helped make him a very rich man. The moral of this story is simple. It takes an act of faith by all parties concerned to become involved in a new technology and that act is rewarded when the future and the present become one, as is now happening with CD-I.

Design Considerations For Interactive Videodisc

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Despite a decade of experience in the use of interactive videodisc in the exhibit setting, we have very little systematic knowledge of what constitutes a successful application of videodisc. Broadly defined, much of the analysis that does exist concerns itself with technical considerations such as the clarity of the screen layout, ways to deal with multiple users, and so forth. However, in this discussion I want to focus attention on an oft-neglected issue that should, in fact, be at the core of the discussion, namely the "design" of the interactive video.

I want to be clear that I am not talking about the "box" (the physical container and monitor configuration), nor about the screen layout (though the value of an easy-to-use, "transparent interface" is quite considerable in dealing with the multiple audiences of museum exhibits). Rather, I am talking about the conceptualization of the interaction. This is the crucial formative stage of shaping the disc (or any other multi-media product); all the broadcast quality production values, elegant screen layouts, and intuitive interfaces in the world cannot make up for an ill-conceived, poorly considered presentation.

As with any other aspect of museum exhibits, the core challenge is to identify the story and determine the right approach to communicating it. One of the most useful paradigms in the field of museum visitor studies proposes that successful exhibits require, in order, attracting power, holding power, and communicating power. Within this context, the screen and its surroundings provide the attracting power, but for the holding and, ultimately, communicating power, an engaging concept (or pattern of interaction) and a clear set of communications objectives are essential. Sometimes interactive video appears to be used more for the sake of bells-and-whistles than because the exhibit planners and designers thought through the range of techniques available and then settled upon interactive video as the proper medium for conveying the message.

As an exhibit designer, I want to talk about some of the characteristic modes of interactive disc design that we have developed during the past 10 years. The simplest design approach is "press a button/see a movie," using the videodisc, in effect, as a more reliable form of VCR. There are many exhibit applications for which this is fine: at a history exhibit, for example, giving visitors a chance to select their own footage to view the topic of their choice, or at a science exhibit, allowing a visitor to see different phenomena accurately demonstrated, time after time. This design approach is also suitable for "repurposing," or selecting material from existing discs to create a program usable in a given exhibit, a low-cost approach to gaining the benefits of the technology without the costs of having to create a one-of-a-kind version.

I would like to devote the remainder of this paper to discussing five additional design strategies we have successfully conceived for interactive video, as well as discussing one currently under development. These hardly constitute the entire universe of possibilities; for example, the Interactive Video Science Consortium has developed two videodiscs ("Earth Over Time" and "Beyond Earth"), employing a variety of design approaches suitable for use in many different settings. I want to emphasize here the necessity of thinking through the possibilities inherent in two traditionally different forms - exhibits and multi-media - and the ways in which they can be integrated.

Diner Disc

The "diner disc" (1983-84) concept arose out of our attempt to find a better way for the public to learn about the nutritional values of different foods in a health exhibit. Good nutrition, we reasoned, is far more than the number of calories or the percentage of carbohydrates that a person consumes; it requires an understanding of a balanced diet, watching for hidden sugars and fats, and being aware of the ways in which different foods interact. We decided that such information could best be transmitted as a series of interactions with a waitress who responds with snappy one-liners, either reinforcing or critiquing the choice. To take fullest advantage of the diner concept and the Los Angeles setting of the exhibit, we placed a touch-screen monitor within a reconstructed diner setting and played the video production for laughs, casting an overly made-up, overweight, "gum-popping mama" as the waitress.

Diner I, produced on a shoestring budget, only allowed a modest number of "food choice" interactions. Based on its success, we designed Diner II (1985), for which we developed a full menu of 72 food selections split between two separate monitors. Each monitor featured its own serving person; in one case, a male waiter, in one case a female. We also introduced a third character, Otto the Chef, who periodically made an appearance. Diner II had two special hallmarks. First, for the Chicago setting of the exhibit we made a particular effort to isolate the food selections to Chicago area favorites. This involved a one-day research trip by the video producer, scriptwriter, and myself to a variety of Chicago restaurants (identified for us by a local restaurant critic) to gather material for use on the disc. Second, we took advantage of the two monitor setup to allow the waiter and waitress to periodically converse with each other. This occurs after a series of trigger "events" unknown to the visitor.

By adding this theatrical element to the interactive video, we were able to produce an additional "WOW" effect. On the other hand, Diner II was not positioned in a reconstructed diner, but rather in a piece of exhibit cabinetry, which we believed was not as effective in terms of creating the overall message context.

There have been at least two other diner discs developed, one a historic diner, with which we were not involved; we take this as a further indication of the success of this approach.

Design Your Own

We developed the "Design Your Own Plane" (1983-1984) exhibit for the Aerospace Museum at the California Museum of Science and Industry in Los Angeles. The purpose of this exhibit was to allow the public to understand that design is a complex process of tradeoffs among user needs, available technology, cost, and schedule. As with Diner I, this project was produced on a shoestring; as a result, we minimized the options. Visitors were allowed to select from a computer graphic display how many passengers they wanted on the plane, what kind of plane they wanted, and what kind of use they were going to make of it. They were then provided with footage of the plane they had "designed."

Although conceptually sound, we felt that Design Your Own Plane lacked depth, and therefore did not really get across the message or take full advantage of the disc's interactive capability. Thus, when we designed the Maritime Center at Norwalk, Connecticut, we developed a much more sophisticated version of this program called "Design Your Own Boat" (1987-88). In this case, the visitor interacts with a naval architect. The monitor is positioned within a real naval architect's desk and file drawers. The drawers are full of drawings of boats; a series of half-hull models complete the authentic feeling of the space. The naval architect guides the visitor through a complex web of decision-making, having to do with the type of boat, the use the boat would be put to, the style the visitor prefers, and related features. Visitors can take pathways away from the main interaction with the naval architect to see close-up features on specific subjects. To keep the exhibit manageable, we planned a universe of 12 boats, one of which the visitor would end up "designing." Even so, the pathways were so complex that we had to write a computer program to figure out which boat went with which particular decision-making tree of visitor choice. The resulting product is quite rich in material about the complexities of boat design. However, it is a rather lengthy program and, in practice, visitors appear to come up in the middle of it, spend a few minutes, and walk off. Even within those few minutes, though, they clearly enjoy their interaction and are able to obtain plenty of information without having to go through the full process of designing their own boat.

Lifestyle Commentary

We designed "Joyce Disc" (1986) for the same exhibit for which we designed Diner II. The overall exhibit was on health; one of the specific subject matters was mental health stress and ways of effectively dealing with it. For the Joyce Disc, we obtained the rights to use existing material of 30-45 second duration concerning stressful family interactions (i.e., sibling rivalry, disagreements between step-parents and children, etc.). This material was originally produced for use by social workers and was intended in its initial form to stimulate discussion between the social worker and his or her clients.

In place of the social worker, we used Dr. Joyce Brothers. At the end of each of the sequences, the visitor was given four choices as to what he or she would do if faced with this particular stressful situation. Dr. Brothers would then comment on the choice the visitor had made and add additional commentary concerning ways in which the stress could be diminished.

Several years later we designed the "Lifestyle Choices" exhibit (1988-89) on the subject of substance abuse. We applied the same conceptual methodology of involving the visitor in a particular set of circumstances, and then allowing the visitor to make a choice or choices and learn something about the consequence of those choices. Five substances were chosen for five different vignettes: cigarettes, beer, hard liquor, marijuana, and cocaine. Since the exhibit was aimed at teenagers, we selected a teenage actor or actress to handle each one of the substances. Based on the widely held belief that teenagers are introduced to substances by peers whom they respect and/or want to be as "cool" as, we set up each of the initial vignettes as an attempt by the actor or actress to draw the visitor into the use of the substance. The visitor was then given a chance to select "yes" (I do want a beer/hit of cocaine), or "no" (I don't). They would then see the sequence play itself out, often revealing the actor or actress as someone who, in reality, was not as "cool" as he or she may have seemed. After the scene played itself out, the visitor was given a chance to "interview" the teenager with a series of questions appearing on the screen. The teenage actor, in character, answered the question, generally in a misleading fashion (i.e., to the cigarette smoker: Aren't you worried about cancer? Answer: Nah, that's only for older people), and then the screen froze while a message appeared on the screen providing the true facts of the situation (for instance, in the cigarette scenario it was pointed out that the earlier you start smoking, the greater your risk of getting cancer).

While the video discs convey their message, the initial character moment is somewhat lengthy; some visitors leave before the full sequence has occurred. Once the interactions begin, people stay with the exhibit all the way through.

Whole TV Disc

In designing an exhibit for the Maryland Science Center in Baltimore, Maryland entitled "Your World: Maryland, Science Behind the Scenes" we wanted to introduce visitors to the science facts underlying their everyday lives. One of the most interesting possibilities was taking visitors behind the scenes to a TV broadcast and allowing them to learn about the science of TV. Using a prominent local broadcaster as our host, we created the Whole TV Disc (1986), a linear sequenced videodisc on how a news story is created. The story is broken into a series of narrated chapters (newsgathering, editing, transmission, etc.). This presentation occupies the bulk of the screen; a vertical band on the right hand side is reserved for scientific or technical terms used by the host in the tour. As each term comes up, the visitor is allowed to touch it, which loops him or her off to a 30-45 second explanation of the science of that term, i.e, miniaturization, satellite broadcasting, etc. For the entire time that the term stays on the screen the visitor can touch it and receive a response. Thus, while the overall presentation is linear from the initial moment of sending a reporter out on a story to the final broadcast, the explanatory loops are interactive and afford much more random access. This "key word" concept is a valuable tool that has been used in some of the new multi-media products in the marketplace.

Baseball Card

The baseball card design approach was developed by New England Technology Group, a consultant of ours, for the "Discovering Dinosaurs" exhibit at the Philadelphia Academy of Science. The "dino disc" (1987) featured 20 dinosaur "baseball cards." Visitors could browse through the cards, obtaining basic information about the dinosaurs, or they could loop off into quiz games, areas of additional information about any of the dinosaurs, or other interactive methods of taking advantage of the baseball card information.

We employed this technique in the Maritime Center at Norwalk as well. The Center includes a regional aquarium; we used videodisc to provide information on a number of species that could not be exhibited within the Maritime Center. Otherwise, the methodology was entirely the same as on the dino disc. This approach is particularly useful for taxonomic types of information.

Living Map

We have conceptualized this approach in order to respond to two distinct but comparable situations: interpretation of a natural site and interpretation of an immersion-type aquarium exhibit. In both cases, for esthetic and practical reasons, we want to avoid a visual overload of signs identifying the variety of natural sights and the number of different species to be seen. The design concept harkens back to the pioneering interactive video, the Aspen disc. Our intent is to "shoot" the site or exhibit in question, then, following upon the work done by Bank Street's Palenque project, to allow the visitor to navigate through the site. Certain aspects of the "trip" will be highlighted as a cue to the visitor of the existence of a menu of additional information. The visitor either takes advantage of this menu and then returns to the precise spot on the tour from which the side trip was taken, or chooses not to "loop" off. Thus, the overall form of the living map is circular, without a specific beginning or end; any visitor can come up at any time during the process and utilize the map.

Conclusions

1. Interactive video - in fact, the larger range of interactive or multi-media technologies - represents a new form. As such, there needs to be a period of experimentation before some standards and general conclusions can be drawn. However, this does not mean that designers of interactive media should ignore the importance of the design aspect of their project; only careful consideration of the possibilities inherent in this new form will encourage standards to develop.

2. Given the modest resources generally available to museums, creativity andeffective use of resources are crucial to a successful application of interactive video to the environment.

3. The most successful applications of interactive video we have used give the visitor many, many chances to make decisions. Frequency and quantity of interactions are what the visitor is looking for in the museum. For example, while the material in the Lifestyle Choices disc is very compelling, because the first 90 seconds go by without the visitor having a chance to interact, we do lose some percentage of the visiting public. On the other hand, Diner II, which is entirely made up of decisions with quick feedback by the disc, is extremely successful.

4. The exhibit environment has a lot to do with the success of the video. Diner I and Design Your Own Boat, both of which are placed in authentic environments suitable to their subject matter, achieve an extra level of success because of the contextual nature of their settings.

5. Resources in a museum or public learning environment are better expended on the programming and disc design than on high-end video production. In only one case, the Lifestyle Choices disc, did we go with what might be considered network quality video production standards. All the other projects were done on tiny to medium-sized shoestring budgets. Museum visitors are not looking for a high-quality video production; they are looking for learning and entertainment.

Note: Portions of this paper appeared in an earlier form in the *A&A Montly on Interactive Entertainment.*

Image Storage And Retrieval
A Tool For Museum Collection Management

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Abstract

The Australian War Memorial is a large and complex museum and research institution. It has recently introduced a multi-million dollar computer system to control and assist in every facet of the management of its collections. The use of on-line image retrieval of collection material is a major integral part of this system, not only for client access to collection material but also for basic documentation purposes. The author examines the role of images for collection management in some depth.

Australia is a young nation. Until Federation in 1901, we were a collection of British colony states. Federation was not the culmination of any titanic anti-colonial struggle; indeed it was something of the reverse, for we were prodded and coaxed, almost hesitantly, out from under the mothering wing. Because we became a nation gently and without any massive social upheaval, we had no truly definite sense of national identity, no heroes, no national archetypes - with the possible exception of the bushranger. The first identifiable Australian national persona came with the first world war. That character was the Digger - the tough, laconic, disrespectful of authority but loyal and brave bronzed Aussie. Like most good tales, the story of the Digger was almost certainly 90% fanciful embroidery upon a thin and hard-stretched cloth of truth. The myth of the Digger has passed into folklore but certainly not out of memory, and this is of primary importance in understanding the place that the Australian War Memorial plays in our cultural heritage.

The concept of the Memorial was formed on the battlefields of France in 1916. The idea of commemorating those who served and died in this war was not unique to Australia, but the institution that has evolved is truly unique in the world. The Australian War Memorial is not merely a ceremonial place, a shrine to honour the dead, but a museum where the living can come to understand, through its displays and its research resources, the full meaning of war.

Australians are great collectors - that is to say, great thieves at the impersonal level. What started out as a collection of the official records of the war rapidly expanded to a collection of anything that was not totally immovable - although we even have a mosiac liberated, tile by tile, from the wall of an ancient building within the confines of the Ottoman Empire, a piece of a middle-ages French cathedral, and a pair of medieval stone lions from Belgium (the lions were, however, a present from the Belgian government). Most people's idea of records does not include tanks - we have seven. Naval projectiles weighing several tons can perhaps be considered paperweights and therefore connected loosely with records, but by no stretch of the imagination would you normally consider field rations to be records, yet last year we found a piece of 1917 cheese amongst our souvenirs. It was well on the way to maturity, and we hope yet to unearth a good port of a similar vintage to match it.

I won't labour the point any further, but I hope that by synthesis you can comprehend our beginnings: a massive collection of disparate objects, without classification or order, and often with little or no description. We also had no staff and no home - indeed, even at the end of the war, no legal entity. Balanced against this was a massive emotional push for the creation of a memorial, for Australia, in proportion to its population, had suffered the greatest number of casualties of any of the combatant nations. There were very few families who had not lost someone, and it is not stretching things too far to say that the first 'crop' of young men of the new nation had been decimated, for there were recorded instances of boys as young as fourteen and fifteen enlisting, and dying - boys who were being born even as the ink was drying on the documents of Federation.

Australia has never forgotten the effects of war on its development as a nation. The Australian War Memorial was the first truly national cultural institution to be created, and in many ways it remains our most important national cultural institution. We have also tended to hold a somewhat favoured status for funding and staff because of the generally high level of community identification and support we receive. However, it must also be appreciated that the community also demands a very high level of service from the Memorial. No other cultural institution in Australia is so strongly regarded as belonging to the people, or has anywhere near the same high public profile. We have to be especially responsive to the demands for service and access placed upon us.

The Memorial is one of the largest museums in the country, with some 8,500 square metres of exhibition space, and over 200 staff. We are currently planning to add about another 8,000 square metres of exhibition space to cater for our in excess of half a million visitors per year. We occupy five individual buildings, spread over a distance of about fifteen kilometers. Two are storehouses, of about 6,000 square metres. These are not normally occupied by staff, and access by the public is only possible through prior arrangement. The

Memorial building houses all of the public exhibition galleries, the Research Centre which combines a library and an archives office, and our educational programs area, as well as our formal commemorative areas. Adjacent to the Memorial building is the Administration building, with the majority of the curatorial staff, Registration, and the normal complement of administrative staff. The casual visitor does not use the Administration building, but there are several specialist reference areas open to serious researchers. This building also houses our computer network central facility. Some eleven kilometers away is our Conservation facility, which also has environmentally-controlled storage areas for paper and textiles, and some of the less stable wood and metal relics.

Our collection includes around 800,000 photographs and about 70,000 accession records of relics - but of course there are many more individual relic items. We have nearly 30,000 works of art, posters and pieces of sculpture, 60,000 plus monographs and serial titles, thousands of personal records - diaries, sketchbooks and the like, thousands of maps - the list goes on. In addition to providing displays in our galleries, we support research into all aspects of Australia's military history - including the other side of the coin, so to speak, of anti-military and anti-war apects such as anti-conscription rallies. We also have a legislative requirement to provide information from our holdings of official government records to establish war veteran's rights and entitlements such as pensions, health care and so on.

The Memorial is quite a large institution, with a broad range of material to manage and an equally broad range of client service demands. I think it is therefore reasonable to say that the functional requirements for our image storage and retrieval system are no less than those of any other large and diverse museum. Having said all that, I'd like to move to the focus of this session - collections management. Before I continue, let me define one point of language. I use the term Image Storage and Retrieval to describe our system, for that is precisely its function. This system does not provide any manipulation, enhancement or adjustment of images beyond mild colour balance correction on both input and output devices. While we also have image manipulation facilities, our use of these is very restricted, primarily to archival reconstruction of images.

We are only now completing the first phase of our image system implementation, so there are experiences to come. However, I can tell you what we have achieved and learned to date, and more particularly, the role we have identified for the system. There are people here far more qualified to talk through the technical intricacies of image systems - I speak as a manager of collections rather than as an image technician. Our image system is in fact one facet of a new computer facility with a total project cost of over A$3 million, to enhance the management of our collection. While the image system is without doubt the show pony, it does not stand outside the rest of the system, as you will see.

The Memorial commenced the use of computers as a tool for collection management in 1983. By 1986, when I started as the Registrar, we had, by and large, our first generation system up and rolling, to control acquisition, location and loan of relics and works of art. This work gave the first really clear picture of what our problems were.

I am sure that most museums will recognise some or all of the following complaints:

- a large collection of badly or inadequately classified and described items;
- a history of lack of control over description vocabulary and format;
- wide variation in the quality, quantity and even availability of control records
- user access demands which are either difficult and costly, or even impossible to meet because of the problem of identifying, locating, or providing access to material;
- physical deterioration of material from repeated handling for user access reasons;
- a need to balance ideal and efficient storage methods with access requirements.

Let me assure you that, if you lack experience of, or exposure to, any or all of the situations on that list, then we can provide a ready educational program featuring live examples. Equally, let me assure you that we see our image storage and retrieval system not as solving, but certainly as helping to address all of these problems.

First, a thumbnail sketch of our overall system. We are now implementing a PC-based network of currently around 70-75 workstations. We use 25-mHz 386 based workstations with 6Mb. of RAM installed. We have two Compaq Systempro 33 mHz 486 file servers, one with 24Mb. of RAM, the other with 8Mb. We are now in the process of instaling out third Systempro to act as a development and back-up machine. The Memorial building is linked to the central network facility via fibre-optic cable, while we have our own microwave link to our Conservation Annex which is some eleven kilometers away. Currently we run on the DOS platform, with Novell Netware networking software.

The image storage and retrieval system allows in-house capture onto WORM laser disks, which are then transcribed onto glass masters. A central bank of players outputs the images to a video-bus network for image transmission to selected network workstations which have an additional image output monitor, controlled from a video frame-grabber card in the workstation.

Logically, the system works like this: users interrogate our computer databases for records which satisfy their enquiry. Not all of our material is yet recorded on our databases, but as part of the overall project we are capturing and even creating records for our total collection. Records which satisfy the search criteria are displayed on the normal workstation screen. When there is an image of the item available, the record indicates this to the user. Users at image retrieval workstations - there are currently seven of these, but the number will grow - can then request display of the image as part of the search routine, by pressing a function key - effectively a "show me that" button. The image location - disk number and frame number - is held on the database record. By software control, the location information is extracted, the enquiry station identification is added, and the resulting request is passed on the network to the image request file server, which commands retrieval of the requested frame or frames from the appropriate player. The image is output onto the videobus, preceeded by the address of the requesting workstation. The requesting workstation receives the image, stores it via Targa frame-grabber card, and displays it on the attached image monitor screen. Output can also be directed either to an attached low-resolution thermal printer, or to a high-quality video printer attached to the viewing station.

Obviously, this is technically somewhat more challenging than my description implies, but it is all current, off-the-shelf technology.

Let me return now to how the image system fits into our collection management activities, and to how it helps us to solve those problems I mentioned before. These problems might reasonably be divided into two groups: those concerned with documentation of the collection, and those associated with physical access to the collection.

The first three problems I listed form the documentation group; that is, they all revolve around the question of the availability and quality of records of items in the collection. Obviously we cannot manage our collections if we do not have some sort of records. It really doesn't matter a great deal what the format of these records is as long as they provide certain basic information: at the very least, sufficient description of the item to identify it, its current location, and sufficient organisation within the record to ensure that it is retrieved in the first place. The larger our collection, and the more demanding our management requirements, the more informative and complex our records need to be. For a museum of any reasonable size, the old days when the relevant curator knew his or her collection intimately have almost gone. Even if such legendary animals still exist, how are you going to access the collection when they're away? Worse still, how will you manage the collection when they are run over by that apochryphal bus?

I know that I preach to the converted - but in practical terms, if you have a large collection, old and inadequate records, and anything less than a plethora of staff and/or cash resources, you are at best struggling to provide both management of, and access to, your collections at the level you would prefer. That is certainly the experience we have at the Memorial, and the problems of access to the collection both for the client and for the curatorial staff are compounded by distance.

Let me now put into conjunction two hoary old phrases: "like trying to find a needle in a haystack", and "a picture is worth a thousand words."

The haystack to which I refer is made up of the thousands and thousands of words contained in the records of the collection. The needle, or perhaps I should have said "needles," are those few words which identify a specific item, or a small group of candidate items, which you seek. Modern computer searching techniques provide the user with enormous power to seek the needles in our haystack. We can allow quite lengthy descriptive captions onto our database, and yet construct a highly specific search through the use of sophisticated searching techniques: character string matching, adjacency searching, Boolean searching. But, if our records are not good, or not consistent, how do we know if we have in fact located the right item or items? One way is to note their locations, and go and physically look at them. Another way is to have additional descriptive material attached to the record which gives us further information - and that brings us to that loquatious picture.

A picture - or pictures, for three-dimensional objects - of an item, contains an enormous amount of information by which to identify that item. Let us look at an example typical to my institution.

A user comes to us asking if we could identify the old handgun his grandfather used to have years ago. He knows it was a souvenir from France in 1916. He can't remember the make - he was quite young when he last saw it - but it was a pistol, he thinks it had a foreign name, probably French or German. He can remember it had a funny shape to the trigger guard and a sort of a hook on the butt. We have over 2,000 handguns in our collection. By constructing the search on the computer carefully, we can select all pistols, of French, German, or Belgian (to be on the safe side) origin, with a date of manufacture earlier than 1916. I haven't done this particular search, but my guess is that the result would be a list of perhaps two to three hundred candidate items. Most of these would be in our armoury, so we could take our enquirer there and start, draw by draw, to examine each candidate. However, for reasons of security, we prefer to keep our armouries reasonably distant from the public gaze. Alternatively, if we had images of all of our pistols on the image retrieval system (which we do not as yet have), we could request these images.

Even if our written records were sufficiently detailed as to provide accurate descriptions of all the physical features of each handgun, which they are not, it would be touch and go that they would convey in the print sufficient idea of the weapon to allow the user to positively select a match.

Such records would be very lengthy indeed, and to read each one would take many seconds if not several minutes. Each record would have to be read almost completely to decide whether the item described was a viable candidate or could be rejected. To plough through 300 records would take almost two hours if the user could read on average one record every twenty seconds - and that is not allowing for any computer response time. Response time for a system holding large numbers of long record is usually quite slow.

By comparison, the mind can take in a picture of a pistol at least with sufficient detail to decide if it warrants close inspection very quickly - certainly in 3-5 seconds. The longest time required to have a selected image appear on the screen is less than 1.5 seconds, the average typically half that. So our user could scan our collection vicariously to make his identification either positive, or far closer to positive - in a little over thirty minutes.

Remember also that if your written records contain a lot of specific technical detail written in the language of the professional, then you may have to supply a professional - a curator - to act as interpretor of the written word. A classic example here would be the correct technical description of a coat of arms or other heraldic device. I will not dwell on the professional time required to create this level of detail in the records, for this is obvious.

Object images have, by and large, no such requirement for professional interpretation. Since our system is usable by most enquirers, even those with very minimal computer literacy, the image system has the potential of freeing many, many hours of staff time from user assistance to other activities.

I have used the example of a user enquiry to show how poor records of the collection can usefully be augmented with images, but the technique equally assists one's own staff who may be identifying items in the collection for any purpose - exhibition design, conservation treatment, research resource, whatever.

This brings us to the second group of problems which I identified: access to the collection.

One part of access is the identification of required items, which we have just discussed. Recording their location is of course a routine entry on the item record. The actual physical access issue bears some further discussion. As with most museums, the vast part of our collection is not on display. Our storage facilities are quite some distance from the main Memorial building, and are basically not accessible to the public at any time except by prior arrangement, and not accessible at all on the weekends, so even to get near the items requires considerable effort on the part of the public and staff time to conduct visitors into the closed areas. Arriving at the near vicinity of the object is not the end of the story, however. For many items, actual inspection requires the removal of protective wrappings or even coatings; they may have to be unboxed, retrieved from special cases, or even assembled if stored in a demounted state. Stabilisation systems may have to be disengaged. Once the user has inspected the item, it has to be returned to proper storage conditions. It is not hard to see that considerable staff time is often involved in bringing the user face-to-face with the item - and if the item turns out not to be the one required, then this is wasted staff time.

We could, of course, simply refuse to make our collection available outside of the material on display, but this is not good museum policy. In our case, we have a special reason to make our collection as accessible as possible. A great part of the collection has been acquired by donation, and as you will appreciate given the nature of that collection, many of these items are of great sentimental value to the owner and his or her family. Can you imagine the effect on a family who has travelled perhaps 2,000 kilometers to get to the Memorial, of being told that they can't see their grandfather's medals and uniform simply because they are in storage? We would lose community support very rapidly indeed; we would also, in all likelihood, find that donations of material would dwindle or cease.

I believe that if we can provide an image, or images, of items in our collection readily for our users, we will satisfy a considerable proportion of access requests without having to go near the material, with significant savings in both staff time and potential deterioration / damage to the material itself. For access requests where ultimately physical access is required, the availability of an image will help reduce the occurrence of false leads, and staff time will at least be used productively.

In one special area, of course, the on-line image replaces contact with the original material almost entirely. I refer to our collection of photographs.

I mentioned that we have some 800,000 photographs. These were mostly taken by official war photographers, but we have some private material here as well. For the official war photographs, we have the negative; for private material we usually have only a copy. We will not place all 800,000 photographs on disk. We have identified a "core collection," currently numbering around 120,000, of these photographs, and these have all been captured on laser-disk.

The advantage for the user of access to the photographic collection on-line is mainly one of speed: many candidate images can be retrieved and examined very quickly to select the required one. Given that the record of the image - which relies on the caption - may not indicate clearly just what the image really contains, it is often necesary to look through many images to find one which is "the best" for the user's purpose. Selected images can then be printed out on the spot using laser printers. For many users, the quality of print from the laser printers will be sufficient for research purposes. However, where the intention is to publish, we will continue to insist that we supply a photographic reproduction of the original to ensure the highest possible quality.

This brings me to the question of the quality of images required in the image storage and retrieval system, which is a fairly natural way to conclude what I want to say here today.

For the storage and retrieval of images, quality is largely a matter of resolution, both for capture and reproduction. The functional characteristics of the system you require really predicates the sort of resolution you need. To a considerable degree the resolution you need also dictates the technology you can use. When we started out looking for an image system, we had no fixed idea of what we required. We examined laser-disk options, which as most people are aware is analogue technology of fixed resolution, and of course digital technology, which can range from very low to extremely high resolution. It became rapidly obvious that we had to determine exactly what we wanted our system to do, that is, what functional characteristics we required. I don't want to go into any great detail, but some of the salient points were:

- speed of retrieval
- minimal influence on the computer network
- ongoing cost of capture and storage
- reasonable cost of reproduction
- acceptable resolution.

We certainly did not require image manipulation, and even the ability to zoom in on parts of an image, while quite desirable, was not considered to be worth significant extra expense or load on the communications network.

The reason we settled on laser-disk technology is that it was the best 'fit' to our requirements. The speed of retrieval is better than virtually anything that digital technology could offer - maximum seek and read time is less than 1.5 seconds. Through use of the video-bus network, the performance of the computer network is not affected by the transmission of images. The impact on the network of the very large file sizes required for high-resolution images is a very serious consideration for a digital system.

The ongoing cost of capture and storage is acceptable. Each laser-WORM disk costs about A$600, and each disk stores 36,250 images per side. The glass master disks cost about $A2000 including transcription costs, and store 54,000 images. All up, using in-house capture, it is currently costing us around A$1 per image to capture and store each image from the photo collection. Each player costs about A$2,500. The recording stations comprising a broadcast quality camera, and the recorder and image processor units, cost around A$45,000 each. The cost of our two stations amortised over an expected 300,000+ images comes to less than A$0.30. For reproduction of the images, the user has a choice of a small thermo-fax copy, which is of fairly low but acceptable resolution for identification or basic research purposes, at about A$0.30, or a larger and higher-resolution laser-print costing around A$2.00. These latter images are A5 size, and of sufficiently good quality to be used as reference prints or even personal record prints.

Finally, acceptable resolution. The laser-disk technology provides resolution of 625 lines for the frame, which works out at about 80 dpi. for an original of about A4 size. While this is not high by digital standards - resolution of 1000 dpi or better is currently possible using digital techniques - it is surprisingly reasonable and certainly adequate for our intended use. If you need greater resolution, then you have no option but to use digital techniques - but you must remember the cost of storage. A full-colour, sixteen-bit image of about A4 size, captured at 300 dpi, occupies somewhere around 34 Mb. The effect on storage, and on network performance, of a large database of such images is very, very significant.

I should comment that the Memorial is also moving to laser-disk technology for audio-visual presentations in the galleries, to eliminate the problems of tape-based presentation technology, but this will be quite separate from our collections management facility.

If there is any message from our experience to date, it is this: image storage and retrieval can be a serious tool for the management of collections, which is, after all, the bread-and-butter of museum existence. As an aid to better documentation, it is likely to be highly cost-effective by comparison with upgrading written records. As an aid to client access to your collections, it has equally strong, if not even stronger, claims. Look beyond merely using image storage and retrieval for exhibition purposes, and the wider role for the technology is readily apparent.

So, What Do You Want To See?

Designing the User Interface for "Ships and Aircraft of the U. S. Navy" An Interactive Multi-media Database Display

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Abstract

Producing the "Ships and Aircraft of the U.S. Navy" interactive multi-media database display for the U.S. Navy Memorial Visitor Center raised interesting design problems:

> How should over 3,000 historical photographs and accompanying data be classified?
> How should these classifications be developed to anticipate the needs of a very general public audience?
> How will the classification system be executed in software?

A careful audience analysis and a very flexible software approach ultimately yielded a successful design.

Introduction

At first glance our assignment seemed straight-forward: Put 3,500 historical images of ships and aircraft, with data about them, into a kiosk so visitors to the U.S. Navy Memorial Visitor Center can brows through them.

But when the first, and most obvious question was asked...

"Who are the browsers, and what do they want to see?"

... a significant design challenge emerged.

The Memorial staff had primarily envisioned the proud Navy veteran, going to the kiosk to show his or her progeny "My Ship". These veterans would be conversant with the Navy's venerable type-class-hull number identification system for ships and would feel quite at home with the pictures.

However, as parts of the memorial opened to the public, it became clear that a major component of the visitors were school children with no real experience of anything military, much less sea-faring.

How might we make this wonderful historical collection equally accessible, equally pleasing and informative to these two extremely different populations, not to mention everybody in between?

We tried to step back and derive some useful design principles for database displays in general which would apply to "Ships and Aircraft."

1. Formal / Informal / Spontaneous Inquiries

It seemed to us that a very diverse audience might come to a display with three kinds of inquiries described as follows:

Formal inquiries come from those users conversant with a classification system established along Aristotelian lines: Order, Genus, Species, etc. In our case these individuals would ask to see the "Iowa Class Battleship BB62 New Jersey."

Informal inquiries come from those users with a functional relationship to the data. These users might just want to see the currently active battleships. It's similar to the inquiry above, but related to time and function more than the official classification system.

Spontaneous inquiries come from the most naive users. Having little or no personal experience of the subject matter, they formulate an inquiry based on some personal criteria of meaning or emotion. "Show me the ones with the biggest guns!" is a typical spontaneous inquiry.

It is worth noting that the above inquiries become broader as they become less formal, but they do overlap. The formal inquiry nets pictures of the "New Jersey." The informal inquiry gets pictures of the "New Jersey", the "Iowa" and the "Wisconsin". The spontaneous inquiry gets the three Iowa class battleships, plus several earlier battleships and some heavy cruisers.

A useful database display must allow for formal, informal, and spontaneous inquiries, without making any of the three seem like a less desirable or intelligent approach.

2. Loven's Theorem of Data Dynamics

A. In a database of given size and power, there is a constant amount of data/time.

B. Data/time has two manifestations: Make-it time and Take-it time.

ERGO: The more time you spend putting in the data and structuring the database, the less time it takes to get something useful out, and conversely, the faster the database is thrown together, the longer it will take to retrieve anything interesting.

This is a silly formalization of a principle that everybody knows instinctively, but which is too often disregarded in practice. The general population has made a startling leap in attitudes about the speed of computer response time. Just 10 years ago, if a computer could pull up a document in less time than it took to go to the library and find the book, it was a miracle of technology. Today, the buzz word is "think speed." If the computer doesn't keep up with one's spontaneous intentions, it is obviously obsolete.

A useful database display must combine clever anticipation of the user's intention with great craft and technological skill in building the software, to maximize response time as far as the hardware will allow.

3. Redundancy is Not a Naughty Word.

Computer programmers have a deep, perhaps genetically rooted, desire to write programs that provide just one way to do each thing that the program does. They were surely shamed in their computer science classes if their code became convoluted or - heaven forfend - redundant.

Non-redundant software, however, places a burden on the user: one must learn how to work the software before using it. And that, as we are all aware, is unacceptable in the museum or exhibit environment. The user will only spend a few minutes at a display, and that time must be spent using the display, not learning it.

The more ways there to do a thing, the higher the chances that the user will intuitively take a satisfactory course, and be rewarded with an interesting experience.

It is useful to note that the user will never know that there were several ways to see the pictures of the battleship "New Jersey." People who say "Won't it be confusing if there are several ways to get to the picture?" have lost track of the actual user's experience. They know too much about the program. The user leaves saying "Hey! I did what seemed logical to me and it worked. What a nice program."

With these principles in mind, we designed the user interface for the program.

In the case of the ships program we user 6 major choices on the main menu:

1. Look at ships by ship name
2. Look at ships by hull number
3. Look at ships by type and class
4. Look at ships by time period
5. Look at ships by mission
6. Look at extraordinary ships

Choices 1, 2, and 3 reflect the formal inquiry scheme, although #1, ship names, also addresses some informal of spontaneous inquiries because some ship names, the Enterprise, the Wisconsin, the Pueblo, may be current in pop culture for various reasons.

Choices 4 and 5 address informal inquiries. Many users want to see a general category, like submarines or ships of the Civil War.

Choice 6 tries to anticipate spontaneous inquiries, especially those that children often make: the biggest, the smallest, the fastest, the oldest, the biggest guns, ships that save lives, and ships that are explorers are available as browsing categories.

The aircraft program is similar in structure offering:

1. Aircraft by nickname
2. Aircraft by designator
3. Aircraft by mission
4. Aircraft by time period
5. Extraordinary aircraft

The concept of redundancy is realized in the menuing scheme. For example, the battleship New Jersey can be found in at least seven ways:

1. By name: New Jersey
2. By hull number: 62
3. By Type and class: Battleship - Iowa class
4. By looking for its mission: Battleship
5. By time period: 1945-present
6. By looking at the list of biggest ships
7. By looking at the ships with the biggest guns.

From choice 4 (mission) on, the New Jersey appears as one of a list of ships. At the extremes, there are 3 Iowa class battleships and many hundreds of ships commissioned since 1945.

The reflection of our design in software hinges on the need for the user to perceive quick system response. It also reflects the understanding that users expect to wait a bit at some points, and expect instant response at others. At one extreme of this proposition, we believe that when a major menu change takes place, the user pauses to re-orient visually, so the system can do some work without the user noticing. At the other extreme, once the user is scrolling down a list or flipping through pictures, any delay is bothersome.

We therefore invoked the theorem of data dynamics in our design. There is, of course, a master database, containing all data. The program itself, however, accesses dozens of smaller databases, derived from the master, which reflect the structure of the inquiry mode selected by the user. When the database is updated, the new master database is fed to the system, which then takes almost 25 minutes of processing time to generate and index all the sub databases.

This large amount of Make-it time is handsomely rewarded in short Take-it time. When a user asks to see the ships with the biggest guns, there is already a stand-alone database of just those ships, which makes flipping through it seem instantly responsive.

Especially given the relatively low horse power of the computer, the response is very satisfactory.

For those interested in the technical details, the program runs on a Sony Viw 5000 system, which includes a 10mz 286 AT type computer. We wrote the program in C, the Master database was entered using DBase, and the utilities which generate the sub-databases is created in FoxPro.

The program currently holds 3600 images, and we look forward to updating and expanding the collection over several years.

Interactive Media & the Museum Experience

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Introduction

"Interactive media" has become a favorite buzzword in the museum world. Most of the attention, and much of the R&D, has focused on the "Interactive" aspect of the technology. For the most part, this is because the technology has been used behind the scenes, in collections management, image banks, etc. This is the most pioneering aspect of the medium and it holds the promise inherent in new technologies. But the emphasis on the technical aspects of hypermedia is misdirected if we want to bring interactive media onto the exhibit floor. Instead, we need to highlight the "media" available to this technology. We need to rethink the image-based media, whatever its format, and evaluate how we design and produce these images for nonlinear, museum applications.

We have emphasized the technical, and sometimes the architectural, requirements of media, but we have largely ignored the actual media. We repackage old news footage into a non-linear program; we collect a database of stills; we scroll pages from a text. In effect, we use as our source material footage that could have been collected in 1953 (and, in some cases, was) but we apply a computer technology to it. All of our magic takes place behind the screen. Yet, in most exhibits, the museum visitor relates to only one component, the monitor. It is a blank canvas in a carefully designed exhibition and we have to, just as carefully, design the many layers of that canvas.

Interactive Media Does Not Exist in a Vacuum

But that canvas does not exist in a vacuum. It shares a visual and a conceptual vocabulary with other exhibition elements, including exhibit artifacts and exhibit space. The monitor exists in a real room, surrounded by real objects, whether they are works of art, scientific instruments or 19th-century industrial machines. It has to hold its own, not compete; it has to acknowledge the links between what is happening off-screen and what is happening on- screen. Sometimes these links may be subtle and implicit.

In "A More Perfect Union", at the National Museum of American History, Washington, D.C., the interactive media introduces several individuals into an historical exhibition. They describe their personal experiences. They do not address the chronology of events that has been depicted by more traditional exhibit elements: newspaper headlines, government documents, even old photographs. Instead, the real people who speak to the visitor from behind the monitor tell real stories, stories only they know, and their presence brings an intimacy to the show. They also help to animate the other, more static elements in the exhibition.

At the Getty Art Museum, in California, visitors can study interactive videos of either Greek vases or rare manuscripts. Here, the connection between the object and the video monitor is more overt. The visitor is invited to explore the various dimensions of the object; he/she can select explicit background information or watch as the camera moves around a vase, stopping in close-up on a detail, or following the curve of a line.

In both instances the interface is clear and direct. The invitation is logical and consistent. In both cases the video discs are sensitive to overall exhibition needs. The visual information in "A More Perfect Union's" videos are intimate, closely-framed portraits; they are one-takes, sometimes halting, sometimes pausing. Likewise, the vocabulary established by the videos in both Getty exhibits reinforces the museum's studied and elegant approach to its collections. In turn, the media become integral to the exhibitions.

Otherwise, the medium becomes an artificial insert that has to be retroactively fit into the exhibition. It is the kiosk set in the entrance to a science center, as if to reassure the visitor that there is something familiar and accessible inside. It is the monitor stuck in the corner of an art gallery, to make an academic show more approachable. It is the speakers pinned to the ceiling of a nineteenth-century period room. But it is not the central component that animates artifacts and text labels.

The Visitor is an Integral Player

Unlike a linear program, an interactive program isn't complete until the unknown user interacts with it. That means that the producer must acknowledge the role of the user and must have a good sense of who this user is. Who is the visitor? Why have they come to this exhibition? What do they expect to see? What else have they seen in the same show?

The same questions could be asked of any exhibit element but there are special demands on interactive media. Nonlinear media cannot rely on the sequential development that linear programs presume. Every shot has to count: every shot has to contain its whole history, since there is no preceding scene to give it meaning and no predictable resolution.

Every image has to be composed and analyzed: to evaluate the quality of the image, the content in the image, and the vocabulary of the image. If the passing visitor has the option of engaging the program, then the monitor has to make a clear and direct invitation and, once that invitation is accepted, it has to be reinforced.

Media is Not the Only Museum Experience

Media in the museum environment, whether linear or interactive, has to acknowledge its neighbors. If it is part of an art exhibition, how does the screen address the works of Picasso, or Rauschenberg? How does the screen address the scale and movements of an actual robot? How does the screen address the surveying instruments of George Washington?

The answers are in the exhibit concept, in the objects, in the design of the exhibition space, even in the institution's mission. A children's museum will answer these questions differently from a science center. A history museum will interpret maps, or even paintings, differently from an art museum. Despite its technical promise the interactive medium designed for use in any of the above is not an all-purpose product. It must be designed, and produced, for real and continued use, in a real space.

In a museum there are many competing experiences. Interactive media are only one experience offered to the visitor. In any exhibition the video monitor is surrounded by significant artifacts, whether they are paintings or hands-on science exhibits. The media created for these circumstances must display the same integrity and credibility as the surrounding objects. Is it necessary, or advisable to depict these same artifacts on the video monitor? Sometimes yes, sometimes not. But the question must be raised: what is the relationship of this medium to its neighbors? How does the information (visual and intellectual) on the monitor relate to the information available in a 19th-century lathe?

Objects and documents bear silent testimony. They can tell us only some things about themselves. They cannot give us context. They cannot demonstrate process. They can't show us the broader social or political context. A suitcase used by a Japanese American on his way to Manzanar may bear poignant witness to a forced relocation, but it doesn't tell us why. And it tells us nothing about the people who are being moved. An old farm tool, set against a farmhouse exhibit at a children's museum, can't tell a visitor anything about how it was used, or the crops that it harvested, or the children who operated it. But an interactive program can introduce the museum's visitors to all of the above.

Media Must Support the Other Museum Experience(s)

A text label can provide some of the same information but there is more power in the image of the tool in operation, in the larger context of an actual field. There is more intimacy in the recorded memory of the former child. As museum professionals we have to evaluate the appropriate use of the various languages available to us. There are times when the printed word is a legitimate source of information. There are times when the image is a more legitimate, and credible, source.

But if we choose to use the language of images we have to adopt an appropriate vocabulary. We have to acknowledge the logic of the visual grammar that we share with the exhibition. Any interactive media developed for exhibit use is more effective, more immediate if it is developed to be integrated into the exhibition, if it is attentive to the exhibition design, its content, the objects collected for that exhibition, and the spatial relationship between these objects and the monitor. Because on the exhibit floor, the monitor is the only piece of hardware that counts. All the design and production efforts have been reduced to this 13-inch box.

Like other design arts, like film or architecture, interactive media starts with a concept, an idea that is unfinished until it takes practical form. The shaping of that form requires a practitioner to engage in a sequence of technical decisions: from the best format for the source material to the most appropriate hardware configuration. At every decision point we have to remember our original concept. It is the premise that informs all of our decisions.

In an exhibition on the history of the U.S. Congress, developed for the Library of Congress and now on permanent display at the Dirksen Congressional Center, in Illinois, an interactive videodisc is used to introduce the visitor to six members of Congress. Each is introduced in an attract loop and a series of questions is designed, for the visitor to pose of each member. The question is written in white font against a blue background with the Capitol shaded into the background. The font selected for the written question is the same that is used in the Congressional record. There is nothing in the exhibition to alert visitors to this detail and the casual visitor is unaware of it. But the visitor who reads the Congressional Record might note it. He might not.

Visitors to the Children's Discovery Museum, in California, might likewise note that the font selected for that exhibit's videodisc is the same black on white script that is found in the early "Dick and Jane" primers; and the program is narrated by a twelve-year old, off-camera narrator. Although the museum's visitors are aged 3 to 13, it was thought that a 7-year old narrator, for example, might have little credibility for the older, middle school visitors. In a small, 13-inch monitor, every detail can be weighted with some degree of meaning. Every detail can be selected to support the broader exhibition content, to reinforce its design, and to directly address the visitor.

Interactive Media has to Work Every Day

But all of this effort is wasted if the technology doesn't support it and to do that the technology has to acknowledge the real conditions of the exhibition. How do we protect a small monitor, placed at eye level, in a children's museum? How do we protect the acoustical integrity of an exhibit on modern language when the exhibit hall is one long open room, full of hard surfaces? Can we make a 26-foot screen integral to the content and design of a traveling exhibition?

If the answers seem obvious they aren't. We have only half the answer and we have to consult with our partners, the people who maintain this equipment, the curatorial and design staff who have developed the exhibition. And the question central to all of the technical details is: how will changing this plan effect the integrity of the exhibition? Will our changes undermine the exhibition concept, or content? The time to raise these questions is NOW, immediately, before the first image is recorded, before the first shoot is planned.

The practical can never be divorced from the conceptual and both must be addressed simultaneously.

One of the "problems" of interactive media is that there are few rules: each exhibition is unique. As a result, the media developed for them is also unique, developed with a particular concept and particular space, designed to support a defined program. However, as the field has grown in recent years, there has been a tendency to adopt a standardized approach to interactive media. We have, without realizing it, created a working vocabulary: of interfaces, controls and configurations. Faced with the problem of designing a program for an exhibition we sort through this vocabulary and devise a workable solution.

To some extent, this is a rational approach. Interactive media are based on an understanding, and manipulation, of technical data and it makes sense to go back to the tried and true. But this is not exclusively a technical problem: we are researching and manipulating images. We are developing and reinforcing ideas. We are arranging these images and ideas onto a screen that is our only contact with our audience. If we truly want to make contact with that audience we must consider the end product of all our efforts. We must think of that empty screen as our canvas, a canvas that will be held to scrutiny for a long time, by our audiences, our clients and our peers.

A New Learning Environment

The NeoMuseum/Children's Media Museum Prototype

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The NeoMuseum in Yoshino, Japan is a prototype for a childrens media museum , an experiment in collaborative research with the goal of creating a multimedia-based learning environment for children. The name NeoMuseum reflects the goal of exploring new roles for childrens museums made possible by new educational technologies. The purpose of the NeoMuseum is to design and develop socially shared electronic media environments for children that exploit constructivist models of interactive learning, and to develop methodologies to account for and foster situations where children become active learners. This paper describes the NeoMuseum and the philosophy behind its development in the context of childrens learning and interactive media.

1. Introduction

The NeoMuseum as an Interactive Learning Environment The NeoMuseum as Research Laboratory

The NeoMusem, a non-profit private research museum constructed in 1990, is located on the banks of a river in the small mountain town of Yoshino. The museum is easily reached by train or car, but its remote setting provides opportunities for concentrated work away from the frenzy of Tokyo, Osaka, and other urban centers in Japan. Students, faculty, and researchers from nearby and not-so-nearby universities and research laboratories visit the NeoMuseum to collaborate on experiments on childrens learning with interactive multimedia and software development. The NeoMuseum provides both equipment and physical space required to cary out this type research. It provides also the opportunity to work uninterruptedly and concentratedly for extended periods of time. Finally, and perhaps most important, by attracting talented individuals from a variety of fields, the NeoMuseum provides opportunities for cross-fertilization and transdisciplinary development of ideas. Thus, the NeoMuseums role as a part of the research infrastructure in the development of future learning environments is perhaps its most important aspect. In addition to laboratory and performance space, the museum also contains an apartment for a researcher (artist)-in-residence, and a tea-house and garden for traditional ceremonies. The expressive architectual design by Hidetaka Hara, the well-appointed media laboratory, and the beautiful surroundings combine to make the NeoMuseum an exciting place to visit and to work. The architectural design for the NeoMuseum is based on the premise that both physical space and the organization of information must work together to support childrens exploration in an information-rich environment.

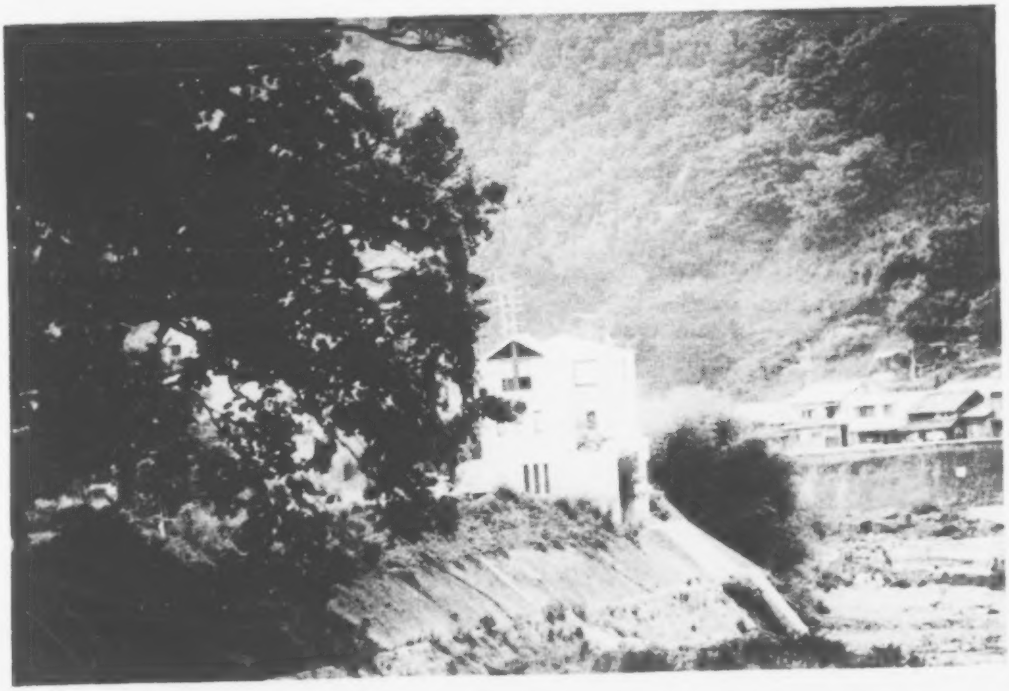

Figure 1. The NeoMuseum in Yoshino, Japan.

The NeoMuseum is a real-size model of a learning environment where children can learn to express their ideas using a variety of multimedia tools. We call the NeoMuseum a real size model because we focus on small experimental workshops for research, rather than providing everyday activities for museum visitors. The development of the NeoMuseum is based on ten years of experience in Japan with LMT, a community electronic media workshop, and on several inspirational educational media projects in the USA. We begin (section 2) with a review of the NeoMuseums historical background and the projects that influenced its development. We then present (section 3) the concept of the NeoMuseum, an interactive learning environment where children can use electronic media for creative expression. We discuss (section 4) ongoing activities at the NeoMuseum, and conclude (section 5) with our wishes and dreams for the future.

2. History of the Museum

The NeoMuseum is the latest realization of a ten-year ongoing experiment in providing a dynamic, social and collaborative participatory environment for children who can make various expressions through multimedia technologies. Since 1981, until moving to the new location, Yoshino, we have been serving both as a place for children to experience creative opportunities offered by new media technologies as well as a collaborative work-place and laboratory to carry out projects. Through the experimental activities, we gained powerful insights from educational innovations in Americas unique projects.

Roots of the NeoMuseum

The NeoMuseums philosophy and ideas of learning environments came from the authors (Ueda) personal experiences in children and media researches over last eighteen years. In particular, Sesame Street of the Childrens Television Workshop and the Logo and LEGO-Logo projects at the MIT Artificial Intelligence Lab and later the MIT Media Lab provided influential models for childrens learning environments based on electronic media.

Sesame Street

Sesame Street was a rigorous experiment which explored the use of TV as an educational medium (Lesser, 1974). The Sesame Street experiment demonstrated the use of the medium (TV) for teaching by fusing significant educational content and entertainment. Twenty years ago, television was the most influential electronic medium for children. We can see many successful elements in the Sesame Street experiment. First, Sesame Street involved a collaborative approach to research and software production. That is, content specialists (i.e. educators, psychologists), production specialists (TV producers, musicians, and puppeteers), and research specialists (formative evaluators) worked together to implement the program. Second, Sesame Street was founded on a clear statement of educational objectives. The program developers translated initially vague educational goals into specific behavioral objectives. Third, Sesame Streets producers and researchers used a systematic and iterative aproach to design and evaluation. In particular, a formative evaluation method (Flagg, 1990) was used to provide feedback to Sesame Streets TV producers and modify program segments based upon childrens responses to pilot segments. These unique approaches for developing an educational media environment gave powerful insights for the creation of our museum.

Logo

The Logo philosophy and experiment, demonstrates how, using electronic media, children can become the constructor of their own learning and knowledge (Papert, 1980). Thus Logo is a powerful experiment of the computer as a learning environment. The original Logo project was in part a reaction to the limited interactivity of teaching machines, programmed learning, and Computer Assisted Instruction (CAI), which dominated educational technology research programmes in the 1960s. In developing the Logo environment, Papert and Feurzeig aimed to produce an open ended computer based learning environment that children could use to construct, test, and express their own ideas. In requiring children to test and debug programs, Logo is constructively interactive. Throughout various phases of Logos twenty-five year development (robot turtles, screen turtles, Sprite Logos color animation, Music Logo, and most recently LEGO Logo), emphasis has always been on providing a programming system where the child can produce and control real-world behavior. In Logo, no preprogrammed interaction sequences drive the learning process; rather, Logo is an interactive programming environment in which children can experiment freely. Control of the learning environment is in the hands of the child.

These projects philosophy and innovative approaches are fed into our experimental childrens media museum projects in various ways. In addition to media projects, research in cognitive motivational theory (Dweck, 1986; Ueda, 1989) and social cultural approach to learning (Wertsch, 1991) gave much insight for the creation of the LMT project.

LMT and The Social Creation of the Self

The LMT project (Ueda,Taetsu, & Chaiklin, 1988) began in 1981 as the Laboratory of Music Technology. We chose to explore music as a domain of expresssion through new computer-based technologies. Inspired by the projects described above, LMT aimed to provide an environment for children to explore musical expression through interactive technologies in a guided learning context (Rogoff & Lave, 1984). We emphasize doing or making music rather than merely learning music. LMT provides a dynamic, social, and collaborative participatory environment with the assistance of professional musicians and technical help for people who want to express their ideas through music and computer media technologies. The main goal of the LMT project was to use collaborative music making activities to affect peoples conceptions of making music and their personal theories of the self as maker. The image of the self is created in the social context of collaborative making. The LMT project was based on the belief that participants can expand their scope of individual and collaborative creativity and develop a more competent image of the self as a music maker.

Social Creation of Learning / Zone of Potential Confidence / joint competence

Novice and coach work together to generate a collaborative atmosphere at LMT. Especially, the coach helps the novice to gain confidence in making music. We view the LMT as a living laboratory where we can develop our theoretical understanding of the process of learning. We are particularly interested in collaborative learning, both from a cognitive and a motivational point of view. We stress the importance of social interaction for the development of cognitive skills. That is, we create a constructive environment where dynamic interaction occurs between coach and novice. We have found that not only novice musicians, but also coaches, can gain interesting insights about a theory of making music and theories of themselves as makers, through collaborative music-making activities. Novice musicians begin to realize their Zone of Potential Confidence, and to believe that, if I work with a coach, we can achieve so much more together. We believes that this kind of conception of ability, social or joint competence, will grow through the collaborative activities.

Making Music in Context: Situated Confidence in Collaborative Music Construction

Just as recent cognitive science research emphasizes that knowledge is situated (Brown,Collins, & Duguid, 1989; Ackermann, 1990), the LMT learning environment is based on the idea that peoples sense of confidence is also situated. Our collaborative model of situated confidence has two distinct aspects. First, the novice learner has a creative role that cannot be replaced by the coach. Rather, the coach must work collaboratively with the novice learner to help bring forth the novices ideas. This interaction takes place around a musical object. Second, it is important that the coach sees a real project to work on. Often in our work at LMT, a coach will become very excited with a students project. Because the coaches are challenged, they cannot use the traditional teaching style of posing problems for the students in which the coach knows the answers and the students must try to discover them. The students can sense the excitement and motivation of the expert musician as the coach starts to work with the project the student has proposed. This excitement helps students to become motivated in the work. The novices confidence of making music grows in this collaborative context.

New Way of Making Music: Editing-in-Action Computer as a Reflective Medium

At LMT, people design and make their own musical expressions through interactive electronic media environments. Based on recent advances in music technology, LMT participants can experiment with new approaches of making music. Specifically, MIDI (Musical Instrument Digital Interface) and digital sampling technologies have radically changed our way of making music. For example, a MIDI-based computer-aided composing system enables the novice to design and edit music and explore musical ideas more freely and reflectively. That is, one can make music by playing the synthesizer while the computer records what one is playing. One can receive immediate feedback by listening to the computer play the music; editing becomes editing-in-action. If there are discrepancies between ones intuitive sense of how the music should sound and the way it actually does sound then one can examine the music reflectively and change it. In this way, computers have changed our way of making music and have made possible more explicit reflective conversation with musical ideas (Schoen, 1983). Digital sampling techniques also enable us to sample natural or acoustic musical instrument sounds and musical phrases just like taking a picture. The uniqueness of both these technologies is that users can freely edit music and sounds to their taste. They dont have to compose music in a linear fashion nor generate sound from scratch as with a traditional instrument or synthesizer. The new technologies suggest a collage approach to music-making, in which sounds from various sources can be gathered, arranged, and rearranged until the music-maker is satisfied. Our early experiences with new ways of thinking and making music in the LMT project have led to our current hypermedia projects, which extend our previous ideas.

The author (Ueda) renamed the LMT to the LMT NeoMusuem in 1984 to reflect our belief that LMT should be a new type of learning media museum rather than merely a music laboratory. Beginning in 1987 the LMT NeoMuseum has been expanded to include a video editing environment, where music and visual expressions can be merged. And in 1990, we moved to a new location and began to redesign our research directions toward a multi-modality media museum.

3. Concept of the NeoMuseum

Theoretical Framework of Design, Media, and Learning in the NeoMuseum

Expression and Communication as Design Expression is the one-way process in which an individual tries to bring out, or shape, an idea or concept into an external medium. Communication is the two-way process by which two parties work together to develop a shared realization of an idea. So long as an idea remains in the mind, we can maintain the illusion that it is clear and well-worked out. Expression challenges the learner to articulate an idea clearly so that others can engage in critical conversation. Through expression one may come to realize that the idea is formulated only vaguely, that one needs to learn more about the idea before it can find proper expression But as we force ourselves to express the idea in an external medium, we must confront and overcome any vagueness in our minds. Thus expression, the bringing out of ideas into media, plays an essential role in learning through reflection in action. The editing in action mentioned earlier is a good example of this.

Media - Interacting with Media/Media as Tools for Communication

Hypermedia as an expressive medium At the NeoMuseum we are interested in using interactive hypermedia as an expressive medium, to provide a learning environment where participants use software tools, both individually and in groups, to construct and annotate their own documents. Unfortunately most hypermedia systems in widespread use today do not provide for user input and user programming; that is, they do not support construction and annotation by novice users. Rather, they offer novices control only over the programming sequence and extent of information accessed from a pre-authored hyperdocument. Thus the authoring system is distinct from the reading system. This fails to recognize one of the most powerful and interesting aspects of hypertext as originally envisioned by Engelbart and Bush, the ability to support real-time annotation, extension, and construction of ducuments. In Constructively Interactive Hypermedia, the users role is not limited to pressing buttons to access pre-stored information. Rather, users can add information and structure to the hyperdocument as well as navigating and exploring previously authored portions of the document. Therefore, one topic of research at the NeoMuseum is the design and development of simple tools for children to author and edit multimedia documents (see below, section 4).

Learning - A Model of Learner and the Learners Mental Model

To make effective learning environments we must consider the learners mental model of the self. Seeing oneself as an innovative and creative thinker and problem-solver is an important step towards attaining those characteristics. A positive image of oneself as a learner fosters the motivation to work hard and enjoy learning. The goal of the Museum is to encourage children to see themselves as capable and creative, and to motivate them to achievement through this empowering vision of themselves. Namely, the main theme of the NeoMuseum is to strengthen childrens conception of how to make things and express their ideas. At the NeoMuseum children construct and extend their personal theories of the self as an active expressionist through collaborative expression-making activities. The NeoMuseum embodies a model of learning which focuses on the learners self-image as an enabling force motivating achievement, curiosity, and innovative expression (thinking).

4. Activities of the Museum

The NeoMuseum is a participatory project oriented learning laboratory, a kind of place where people can come and work. It is also a kind of school workshop where teaching and learning take place through interactive multimedia projects.

The NeoMuseum provides facilities for electronic music, video, desktop publishing, and multimedia projects, and it attracts people with a wide range of experience and expertise. With a good mix of novices and experts teaching and learning is always going on. It can also be a place for collaborative projects where two people, each expert in different skills, collaborate on a project and learn from one another. For children there may be special, more structured workshops where a coach or instructor leads a group through some exercises. The NeoMuseums idea about education is to provide an environment rich with opportunities for learning. The mode of learning is informal but effective and exciting. In order for this informal model of learning to work, it is essential to have experts around to supervise the apprentices. In order to attract expert practitioners who can serve as coaches, the NeoMuseum provides good facilities for making electronic music, video, and multimedia projects. This attracts experts, who then serve as masters to help apprentices who come to Museum to learn and play. Thus the NeoMuseum serves simultaneously as a community work-space, a learning-space, and a performance-space.

Figure 2. Children work with multimedia at the NeoMuseum.

The NeoMuseum depends on having enough people with a shared interest (electronic music, graphics, or video) to begin to establish a community. Our experience with LMT suggests that by providing facilities, workspace, and a supportive environment, a community can easily form. We concentrate on the domain of expression and communication and we equip the lab with a useful range of tools to support this domain. In theory, of course, the same principles or concepts apply to many domains, but to put the theory into practice, we have limited our scope to a small program with a sharp focus.

Research Two projects are currently underway at the NeoMuseum. The Animemo project, an experiment in animation as a story-telling medium is being carried out in collaboration with the Research Institute of Media Sciences in Tokyo (Maeda & Sabiston, 1991). The Yoshino Mapmaking project is being developed in collaboration with local residents interested in using new media to represent information about the history and geographic features of the Yoshino district. These two projects serve to illustrate the kinds of research activities that an experimental media museum can foster.

The Animemo Project - Children as Formative Evaluators

Animemo is a program being developed at the Research Institute of Media Sciences in Tokyo and tested and employed at the NeoMuseum. The Animemo program is a simple authoring tool that children can quickly learn to use to make animations. Our experiments with children using Animemo suggest that animation is a powerful way for children to engage in interactive storytelling without the usual constraints of text or still pictures. In developing the software, the implementor observed children using the Animemo prototype. In light of the childrens experiences and discussion, the software was interactively revised during testing at the NeoMuseum. Thus the Animemo project is a good example of the collaboration possible between museums and other research and educational organizations.

In preliminary Animemo experiments with groups of children, we found that children enjoy both entertaining, e.g. showing the animations they have made, and being entertained, watching other childrens animations. Thus collaboration is fostered naturally in the NeoMuseum learning environment. We have also informally observed that childrens confidence in their ability to use Animemo as a storytelling vehicle grows rapidly.

The Yoshino Mapmaking Project

In the Yoshino Mapmaking project we are exploring hypermedia authoring and personal database making by children. A map of the mountain village of Yoshino and the surrounding areas forms the user interface to a hypermedia database. The database contains textual, graphic, audio, and video information about places of interest in the town. In addition to reading, viewing, and hearing information already stored in the map, children can add their own annotations and information about places they know.

Through this project children can gain better information about their own town or local area, and they can access knowledge put into the map by others. Children are asked to interview older residents and to put what they learn into the map database. Later, other children can access this information. Thus the hypermedia map can serve as an intergenerational communication tool. Through this process of making and browsing this hypermedia map, children can naturally understand otherwise difficult hypermedia concepts.

5. Conclusion

Construction of the NeoMuseum was completed at the end of 1990, and our first round of projects is just getting underway. It is therefore too early to report on the results of our research. Nevertheless, we are confident that the NeoMuseum can fill a valuable niche in learning environment research by offering the physical space for formative evaluation, testing of prototypes, and development. Especially in Japan, where a highly competitive educational environment tends to discourage learning that is not focused on scholastic achievement, highly interactive multimedia learning environments can provide alternative educational, expressive educational experiences. The NeoMuseum is a working, life-size model for how to develop these multimedia environments, in collaboration with universities and other research institutions. As we have stressed abowe, constructive interactivity, the participation of learner-users in structuring hypermedia, is of particular interest to the NeoMuseum.

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The Meanings of Images Across Cultures

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Abstract

In this paper we present our videodisc project (a videodisc of multinational print advertisements) asking the question, "Who will be the audience?" In order to answer it we engage in a comparative analysis of the construction of the reader/consumer (audience) in French and American advertisements. Our first comparison takes into consideration the imaging of men and women in perfume and cosmetic ads. Next, we look at Americans and French looking at each other across the ocean: stereotyping constructions by the foreign 'other' help us to destabilize our most cherished notions of ourselves and at the same time allow us to open ourselves to new ways of being in the world.

It might appear redundant, inane, perhaps a bit suicidal, to propose to produce a videodisc that houses some 54,000 advertising images from the print media given the ubiquity of advertising in our world. It is estimated that the average American is subjected to between 1000 and1500 ads per day. Advertising, moreover, *pays* to make itself seen and heard, or at least pretends to give itself away free. Who, then, especially in a logic of supply and demand, would be a willing and benefiting audience for yet more commercial exposure?

It is precisely the pervasiveness of advertising in today's world that has led us to collect and analyze these quotidien texts of consumer society banality. However much one tries to ignore or avoid advertising, it continually infiltrates deeper and more broadly into almost every facet of communications in the world. It has been said that advertising serves the function of artistic cultural production in the twentieth century: as such, it follows the "making strange" of the familiar that characterizes aesthetic production and consumption. We have found, however, that advertising's "foreignness" operates more on a surface level and that specific social attitudes and practices are meant to be preserved at all costs.

Our project in general and specifically in this paper is to "read" advertising through comparative lenses. Through the juxtaposition of culturally (here, as functions of the nation-states of France and the United States of America) different commercial presentations of the same products within the same time periods and in publications directed at roughly the same class, we propose to demonstrate some of the most salient features of identity construction in France and the United States.[1] We are surgically targeting the "banal" images of ourselves as consumers.

The first set of products we have chosen are perfumes and cosmetics. These are particularly potent in their construction of the reader as consumer because they almost always have recourse to normative images across which, the advertiser hopes, consumers will foresee a post-purchase mirror image of themselves reflecting off the page or a dream-like but realizable experience or set of possessions. There is an imaginary moment that individualizes the mass reproduction and consumption of both ad and product. At the same time, there is the effect of taking on a social mask that corresponds to a constructed social norm.[2] This norm is that of "buying into" what the advertising industry would have us believe is a culturally acceptable - and culturally self-defined - image of desirability. But, of course, this play of "normative" desires is never articulated by the advertiser nor is it supposed to be recognized in the "mirror" by the consumer. The strategy here makes use of peer pressure, of blind acceptance of the myth of belonging to a community (of consumers): what used to be a "religious" function.[3]

Christian Dior sells well in both France and the United States. Yet the advertising strategies follow significantly different paths. In France it sells on its own coattails: it is an epitome of French cultural production, status, and quality. The name says it all. For the American scene, with a much more diverse population and without the historical and cultural connection to the name, Dior has to plumb other than cultural chauvinism: in fact, it is its foreigness that acts as a prime catalyst in establishing its appeal.

In the American Poison ad from 1987-91 (illus. 1), the model is cold and distant. A call to an exoticism outside Euro-America masks her face in a sort of "oriental" geisha whiteness that is encircled in the coils of a satin snake both on her head and upper torso. The lacy black see-through gloves bespeak, too, the serpent of a Poison. The poison is like that from the Garden of Eden, where the snake has seduced Eve into taking the poison apple of knowledge. Even the model's arm and hand hint at some vaguely oriental-like gesturing. She offers her gift, poison by any other name, to someone off-camera. Her downcast eyes, perhaps they are closed in a trance, neither regard the magic potion she proffers nor the person to whom she extends it. The colors, dark blues, purple, black - especially against her characterless face - reinforce connotations of distance and coldness. This American ad highlights the blue tones of the purple whereas the French versions will tend more toward the red spectrum. She intones her incantation, "Poison is my potion." The sorceress weilds her potion that will enchant others: she will seduce them, but without her own excitement. The deep blood red of her printed words steps out of the dark, cool colors of the rest of the ad adding emphasis to their power. Perhaps she epitomizes the woman able to transcend national boundaries: she is not American, French or "Oriental" but then again she is all three.

She is transnational - just what the woman (American) of the 80's and 90's must be with all her power, her charms, her dispassion, her knowledge, and her multicultural and global views.

Though the reader/consumer is not expected to envision herself made-up and garbed as the model is, the idea is for her to picture herself transcending some identifiably everyday American face after having bought and applied the product. The transformation operated by the magic potion (which is both the product and the ad - image as magic mirror and text as spell) is that of normal woman into powerful, charming, supranational being. Beguiled by the spell of the ad, we consumers - like newly inducted vampires - now see ourselves in her image and likeness. We are now ready to promote our potions to the four corners ofthe earth.[4]

An earlier French version (1986-88, illus. 2) had already launched an exotically oriental, Bali-esque tone. The contrast is striking, however. The French version, while maintaining a distance between reader and image through the camera angle and model's eyes looking skyward, emphasizes human skin. Whereas the American model is swathed completely in mask-like makeup, the voluminous coils of cloth and the black lace gloves, the French model is nude, her sensuously French hands, shoulders and face clearly visible. In fact, even her hair, slicked back and away from her face, does not veil her sheer nudity, nor do her nails seem covered by polish. Only the gesture of her hands suggests a dancer from the South China seas. Equally striking is the verbal difference: the French is a "vous" whereby the woman reader is addressed as "you" ("vous" is both the formal and plural form of address to "you"); in the American, the image speaks her selfdom and individuality, "Poison is *my* potion" (emphasis added).

Compare, now, the contemporaneous Poison ad from France (1990-91, illus.3) and its American counterpart. The French ad again breathes the sensuousness of the model's body - lots of skin. The shot is much closer than the one taken of her American counterpart. The focus squarely on the face expresses a "jouissance douce," a thoroughly and fluidly sensual pleasure. Her closed eyes are not those of a bewitching or narcotized woman, rather those of a woman fully enjoying her body. The eyelids are softly shut, her full lips curve up only slightly in the suffusing pleasure. The color, a deep rose tending toward violet remains within the warm tones, not the cold blue tones of the American version. Her nostrils breathe in life and let her savour the perfume: the American model doesn't even have nostrils, her nose indistinct against the white mask. The American woman shows no hair: not a wisp slips out of her coiled headress. The French woman's hair does not shine; it even looks stringy (to the American way of viewing hair) - but it is very "natural," "real." American advertising insists on shiny, bouncy hair (though recently the moussed or gelled dull look has become acceptable)--or none at all (a la Breck girl). The French model's chin is dimpled by the cap of a perfume bottle that then casts a violet tint down her neck. In the earlier French version, too, the bottle cast its violet hue on her bare shoulders, accentuating the corporality of her skin.

In both French ads, perfume flasks - always touching the women - proliferate. In the current version, a cascade of bottles repeats the undulating, fluid lines of the glass container and the contents. Unlike the shock of angles and curves in American ad, the French bottle layout appears sinuous and flowing. Where the same presentation of product and packaging appears for the earlier French and the recent American - both in the lower right hand corner - the French is far less remarkable, nearly a third the size of the American counterpart. The difference in size of the black border also renders the French product identification far less obtrusive: it is nestled down in the corner under the model's shoulder. In the recent French version, the label for Christian Dior is much larger than the American but not nearly as forceful in spite of its location on the top: its light lavender inch and a half lettering lacks the shock of the white on black, half-inch letters at the bottom of the American. In both French versions the product name is clearly delineated in an additional textual moment. The American shows it only in the caption of *poison* being her potion.[5]

The French reader/consumer is meant to recognize a generic version of the French woman, a group of which she is member. She identifies with the slightly exotic, slightly quixotic, but still thoroughly in-the-flesh model of the first ad, and even more so with the pleasure-filled woman of the second ad. Through product purchase she will simply continue the reality and perhaps benefit from some sensual moments. Perfume in France participates in a cultural savoir-faire. In addition to recognizing quality in the Dior mark, all French woman know that perfumes react to individual body chemistries; hence the emphasis on the woman's skin, her "bodiness." The ad is meant to encourage a French woman to sample the perfume to see if it goes with her personal chemistry. In so doing she perpetuates the French culture of perfume.[6]

To reinforce some of the contrasts we noted in the Poison ads, we will juxtapose other French and American perfume and cosmetics ads (illus. 4). The top set is French. The women maintain the "jouissance douce" of the second Poison ad. The Smalto woman on the far right, however, goes somewhat beyond "jouissance" into "ecstase" but we will address that below. All the French emphasize skin. The bottom row is American. There tend to be two strains of American women: the "looking you right in the eyes" type on the left and the narcotized, "out of her right mind" sort seen on the right.[7]

In short, the French ads set up a triangle of desire in which the current reader desires the pleasure incurred by the woman in the photograph such that she imagines the off-camera scenario: a lover - having been lured by the product - does wonderful, sensual things to the model's body. The logical connection desired by the advertisers is that the reader recognize herself and her future pleasure in the ad and hence will offer herself this pleasure promising purchase. By contrast the American woman either seeks control or is beside herself in some sort of puritanically repressed sexuality.[8] In her role as controlling enchantress she uses the product-potion-poison to manipulate others: she, indeed, wields the power of life and particularly, death. On the left, again we find the woman in control. Her eyes looking straight into ours in defiance. We look back at her. . . we *become* her looking at ourselves in post-product purchase and application of assertiveness. We have become strong, individual, defiant. Or, distant like the enchantress, she is removed, in fact, removed even from her own body, like the woman on the right. The pleasure of the Smalto man is not hers to enjoy directly. She appears to be in a drugged state. But we will explore this at greater length below. The American desire is not obviously triangular and immediately sensual, nor mediated by an off-camera lover; the American desire is veiled and repressed sexuality or it is a challenge.[9]

To reinforce our point, we finish the perfume/cosmetic section with the Smalto ads for men's perfume. "Smalto.You make me weak," intones the American woman in a swoon (illus. 5). As we noted above, someone has either just ravished her or will soon do so. In her condition, the ravishment is secondary to the force of the Smalto experience, i.e., the perfume or raw male sensuality has overwhelmed her already. The period following the word, Smalto, makes it either a statement ("Smalto. Oh, that's what did it to me.") or an address ("Oh, it's you, Smalto,who coming."). Regardless, she is not responsible for what happens to her body and she can remain pure in her thoughts. It is not her fault. So forceful is the perfume that it assumes the man's full identity. She addresses Smalto, or accuses Smalto, for her succumbing. Who is thereader/consumer? Good question. A man who wants to bowl women over with his "essence" or a woman who wants to enjoy sex with a Smalto man but without the guilt?[10]

In the French version, the woman bites her hands in a look between playful fear and enjoyment (illus. 6). She is consciously over-dramatic. It is a game. She looks at the Smalto man. He is the reader of the ad who is either ravishing or going to ravish her. This is evident in the caption where the comma indicates that Smalto is the proper name of the addressee: "Smalto, tu me fais craquer" translated as, "Smalto, you (familiar form of address of a friend or lover) blow me away (more literally but misogynistically, "you make me break apart"). Everyone is enjoying - the perfume, the dramatics, the sex. The real reader/consumer is ambiguous, however. Is it the man who would be Smalto? Or is it the woman who will purchase the Smalto so as to turn her man into Smalto and, thus, herself into this finger-biting, playful beauty?

Other men's ads support the ambiguity of the reader/consumer (illus. 7). We note however that these ads, although appearing in men's and women's magazines, were taken from women's publications (*Elle*, *Marie-Claire*, *Vogue*). We also note the continued sensuality and human sexual contact intimated in the French ads in contrast to the sexual titillation-in-repression-and-denial of the American. The French Fendi models are skin to skin, caressing. The American model wears an expensive fur coat between her and the man-turning-marble she examines. He does not acknowledge her presence. It would seem that he is an anti-Pygmalion turning stonier, rather than going from stone to flesh. Whatever the case, she adores him aesthetically and perhaps somewhat sensually. The attraction is in the aesthetic appreciation of the Roman antiquitics, in their incalcuable worth, wherein one recognizes the operation of an elite knowing true value.

The Xerus ads offer us a different optic on the construction of a reader/consumer in that neither portrays a human being. In the French version, the blood red, stormy sky frames the upward thrusting, virile bottle of Xerus and its craggy, very masculine, granite pedastel. The American version highlights the social relations of the user. He has won a loving cup, he is interested in maps (either old, intriguing ones or new ones to plot his adventures). Where the French underscores the solitary strength of the Xerus man, the American emphasizes his winner's sociability. The French is a man's man, the American is a man among men.

For an even more striking comparison of the French and American audiences for advertisements and the logics of cultural marketing, we turn now to the portrayal of the French by Americans and the Americans by the French. For the first, we will note the extent to which Americans exoticize the French in ways contrary to French notions of how they act and see themselves. The same is true for the French notions of Americans: if you are American, you will not recognize yourselves in these images.

"Tonight, be French," is the caption for this American wine ad for Mouton-Cadet (illus. 6). The image represents what is supposed to be a French woman seated in a cafe in front of her wine and dessert. Yet nothing in the image of the woman, however chic her look, the type of clothes and jewelry she wears, nor her behavior appear French to a French person. The criteria for determining the authenticity of this woman as a French woman are difficult to articulate, but with respect to comportment, there is no doubt. Few French women go to a cafe to drink wine, and in France, red wine rarely is taken with sweets. The gap between this image and a realistic representation of French social practices for anyone familiar with the culture is striking. Her look, too, is that of an American, the direct-in-the-other's-eyes we noted in the top left image of illustration 4. She engages the reader either to identify with her in a mirroring image (she is us, a woman peering into a looking glass) or to be enticed by her exotic Frenchness (she is seducing us, a man who wants her for her *savoirs*). In both instances, the sign of her Frenchness is meant to override our American sexual repression - though the taboo on imaging it remains inforce. It is hinted at in the gaze and the syntactic emphasis on "Tonight" in the verbal text.

The same type of strangeness arises as the French look "d'outremer" at Americans in Winston commercials. This campaign presented the French viewing "L'Amerique sur le vif" that is, "America, live." In the first image (illus.9) the New York businessman-hero has removed his jacket, even his shoes and socks, to dip his feet in a fountain bordering Rockefeller Center. His back against the cool marble of the fountain, he peruses the *Wall Street Journal*, while dunking his toes. Still, one notices that his attache case is wide open, that he has a phone and a calculator: the proof that this man is not just relaxing, but that he is working. Thus, as he checks the columns of numbers in the newspaper, a smile flits across his face. Here is a man satisfied with himself; he has just realized a juicy stockmarket profit. From the upper left hand corner, the American flag gets repeated in the red and white stripes of his shirt, then along a diagonal into the red and white Winston lighter. For the French the message is clear: Winston is America and therefore success, all the while relaxing.

Another young, dynamic executive has chosen a unique means of transportation: he zips around on roller skates (he is sporty, savvy, cool). He is sure of himself: no fear of falling, he even has one hand in his pocket despite heavy traffic as he glides down the middle of the street. He is so fast that even his dog seems out of breath. He is elegant in his suit, bow tie and pocket handkerchief, and well read with his *New York Times*. Once again American flags and colors reinforce the American look, the American hook, of the image. It is supposed to elicit the reader's admiration for the handsome, intelligent, sporty, easy-going, assertive Winston man and thereby to arouse desire to be like him: which can be brought about by consuming Winston cigarettes, the magic catalyst of dreams.

Once again caught in traffic jams, but this young man opts to flirt with a young woman. He has his red convertible VW with cellular phone (rich but not ostentatious and most certainly individualistic), while she stands up in her Mustang, also convertible. He cavorts, trying to get her to go ahead and use his phone; she recognizes his charm. For the French reader of this ad, there are all sorts of "Americana" being imaged - like Buster Keaton movies. For the same age, same class, American reader, who generally has a different slice of American "memory," these allusions are lost. Again, the clothes reflect French attitudes toward young executive dress codes and the desire to be easy-going, like an American - coat off but bowtie still on (we loosen our ties before we ever doff the jacket). The importance of the dress code, too, is lost on the average American reader: the French are much more rigid in this etiquette.

Though the American flag is missing in this image, its colors are ubiquitous: the red and white cars, the red and white street sign, the red and white clothing, the white background and red Winston lettering, the red and white packet in the bottom right corner. Bits of blue float around: steering wheels, pedestrian clothes, reflections. Winston is America, America is Winston. Winston people know how to transform disagreable situations into fun.

The other Winston ads continue this line of thought: Winston men put their bikes into cabs, play chess in classless cafes, play jazz trumpet at work. They triumph over city stress: they make New York theirs, a fun and successful place to be. They don't have to deal with tiny French cars or French taxi chauffeurs who would never allow a bike to damage their cabs. They can rub elbows with bikers and blacks. They can impress co-workers, especially secretaries with legs up on chairs, with musical virtuosity in the workplace. French men can be just like them by buying Winston (note, of course, that the cigarettes are neither pictured nor smoked in any of the ads: it is either the "Winston Way" or Winston lighters being marketed). The major attraction is the active but relaxed lifestyle of the New Yorker - but not in the New York of traffic jams, pollution, racial and class tension, eroding tax bases, crime, stress, fear of AIDS and acquaintance rape, fourteen hour work days, inflated prices, et ainsi de suite....

The audience is located differently in these ads than in the perfume and cosmetic ads. There we were up close, peering into a mirror or part of a sensual experience - close enough to be participating (close-ups). In the Winston series, we are part of a narrative taking place. We are close enough to see all the action, to "read" the young man's life, even be somewhat involved. In the first ad, we are located somewhere in the fountain also cooling our heels or just on the opposite side, maybe dipping our toes, too. As a French person, regardless of the exact location, we are enjoying New York and freedom. We necessarily have taken off our jackets and loosened our ties. The same positioning is operative in the skating ad: We are in the middle of a crowded New York street, on the yellow lines. We might even be skating backwards to look at our buddy. Then again, we might be in a cab looking out the rear window. Whichever the case, we are sharing the exciting, freewheeling life of the States - and what is more, he sees us and thus validates our being with him in this reality.

The recognition of our being there is exploited in the convertibles ad. The young man focuses on his shenanigans, but the young woman is looking at us to express her amazement and joy. We share - maybe pedestrians passing in front, maybe fellow jammed up motorists (we may even have caused the jam as our car travels perpendicularly to theirs) - in her fun here in the land of fun and plenty.

In the office ad, too, we participate. Obviously, though, everyone, us included, is paying attention to the jazz recital. We are audience members just like the secretary and the other executive. We are all together here in this skyscraper, closing an important American deal in our outrageous New York style. The taxi-bike ad engages us less. The angle of the cab suggests that we are in a vehicle passing in an opposite direction, going uphill. Here we are a part of the fast lane of NYC, catching just another moment of exhilarating American life. As for the cafe scene, we are standing above the players, though their faces would seem to indicate a more than our passing interest. We are not at the table-game board with them, but they may well invite us to sit down: Jack turning his pointing finger up at me. He will joke about what a silly move Joe just made and we will all laugh. Or maybe I just stood up from the chair in the lower right hand corner. The moment is convivial: I'm in New York, thanks to the Winston way.

In all the Winston ads, there is emphasis on visual and verbal narrative in which we, as readers, are implicated. We have taken the Winston Way, all roads lead to NYC. Or else we are participating in "L'Amerique sur le vif" - where "sur le vif" is an artistic term meaning to capture an image from what one actually is seeing, "live." We are catching these scenes as they happen because Winston makes it happen for us. Even if it is vicarious, mediated by these ads, for a moment, however brief, we get to let our hair down and be "cool" and easy-going like Americans. This is extremely important in a society which by American standards is restricted by traditional etiquettes: dress codes, use of cultural objects (like perfume or wine), public behavior. Importantly, too, we are framed as young executive, probably white, men (the women in the two ads that portray women relate to us as men) despite the fact that cigarette smoking in France, as in the States, is growing faster among lower class, minority and female populations.

In one more example of the French vision of Americans, we look at the Prisunic "Belle Americaine" (illus.10). Here is a tourist who dares wear shorts and comfortable tennis shoes - which a Parisian woman would never consent to don in-city. Our tan young woman, healthy and enthusiastic, represents one of France's dearest stereotypes of American tourists in Paris, tout de suite off to see the Tour Eiffel and buy and wear, all a-giggle, her souvenirs. Though her legs are too muscular for American fashion models and her stance is a bit too boyish, for the French she is quintessentially the "Junior-year abroad" student. Americans, to the contrary, are more likely to picture themselves in France sopping up cafe life and "real" culture (museums, monuments, left and right banks, romance, couturier clothes) than the silly, touristy things they really do engage in! A quick glance at advertising material for study abroad programs will verify this.

The consumer/reader in this ad is toe-to-toe with la Belle Americaine. She has sighted us, she recognizes us, and wants to play with us. Indeed, her stance would seem to indicate a tennis match. Here is a sport where Americans and French can compete on even grounds, n'est-ce pas? As a French young woman - the product and the text indicate that we are such - we look forward to "hopping" around with her, brushing up on our English, accruing "chic points" for having an American "friend."[11] As in the Winston ads, brushing elbows with Americans permits us a respite from French cultural confines.

For the French, then, Americans are sold as the epitome of sportiness, fun, fast money and easy-going charm. For Americans, the French are signs of savoir-faire, savoir-vivre, sophisticated chic. These images are ones that each culture recognizes comfortably, ones that in our imaginings we want to "buy into."[12] A New York city that resembles too much a troubled Paris does not sell: fantasies of individualism and wide open spaces do. Homeless people or American intellectuals - an oxymoron for many Europeans - don't sell: cute tourists to reinforce stereotypes do. Our exotic dreams are culturally biased, too.

Even such products as apples and beef are portrayed in culturally determined and determining ways where the relationships between product and consumer, and the representations of these relationships are subject to specific albeit often unarticulated rules. One of these relationships which we have not explored here is the positioning of the ad in the media. Raymond Williams in *Television, Technology and Cultural Form* (NY: Schocken Books,1975), for example, has argued that the placement of programs and ads are functions of rhetorical strategies and cultural forms. His notion of "flow" can be applied to print media as well.[13]

The videodisc we are proposing will allow us to demonstrate even more convincingly these differences. Thanks to the volume of images possible and the ease of manipulation via computer, we can evince cultural differences quickly and easily. We can also track the historical developments of certain notions and images. In particular, we can make the familiar unfamiliar and thereby encourage critical looks at latent cultural biases and open ourselves to the pleasure of other ways of being in the world.

Notes/References

1 Alain Rey in "From money to dream: a return ticket" in *Marketing and Semiotics*, ed. by Jean Umiker-Sebeok (NY: Mouton de Gruyter, 1987), p.32, has noted how the very notion of marketing, for Americans, is a conceptual field that points to a part of any economic system that directs the flow of goods and services form producers to consumers. Outside the USA, however, the conceptual field is limited to economic theory and research specifically

related to modern, post-industrial and competitive economic systems. In practice, too, this divergence in conceptual fields is articulated in the American ethos of creating product desire as opposed to the European practice of responding to a perceived consumer need. Here alone cultural difference is manifest in the pretense in Europe to a notion of utilitarian production that recently has been dethroned by the likes of Baudrillard, elsewhere bemoaned as "Americanization" via our commercial media (eg. Michele Mattelart).

2 The dual operations of advertising as concommitantly force of change and force of preservation are noted by many communication theoreticians, from Burke to Williams to MacLuhan to Geertz to Eco to Barthes as noted in John Sherry, "Advertising as a Cultural System" in *Marketing and Semiotics*, op. cit., pp.441-461.

3 Benjamin makes a strong case for the sacred functioning of certain operations in mass reproduction as the modern world reorganizes its values away from cult values toward exhibition value. The value becomes that of reproducibility itself. We have to believe, not in the "stars" and the individuals who have made it rich, but in the myth of capitalism, that everyone has equal access to becoming a star or a member of the five percent elite. (Roger Benjamin, "The Work of Art in the Age of Mechanical Reproduction," *Illuminations*, ed. by Hannah Arendt, trans. by Harry Zohn, NY: Schocken Books, 1969. pp.217-251). The marketing strategy behind the construction of this myth is discussed by Philip Kotler in "Semiotics of Person and Nation Marketing" in *Marketing and Semiotics*, op.cit., pp.3-12. Marian Flick ("Advertising Manipulates Women's Lib", ibid. pp.533-542) notes the function of ads, the art of capitalism, citing Williamson (*Decoding Advertisements*, London: Marion Boyers, 1978; p.13) based on Williams, that of fulfilling one of the traditional functions of religions and arts:

> Advertisements are selling us something else besides consumer goods: In providing us with a structure in which we, and those goods, are interchangeable, they are selling us ourselves. (p.533)

4 Women are the ostensible audience/consumers for these ads. Yet, it has been convincingly demonstrated that the "real" audience is some transcendental father/god or at least the man with capital potential. The missing image is that of the real man behind the scene, perhaps not just Adam, but also He-who-Is. (see Dean MacCannell in *Marketing and Semiotics*, op.cit., pp.521-531) Though a woman (model - selected by an ad agency, usually headed and run by men) is a sign that sells a "feminine" product (also male-driven and owned, Christian Dior *is* a man) to other women (whose money usually comes from father, husband or male boss), the entire female economy of this product is predicated on getting or keeping a man.

5 Dean Mac Cannell (op. cit., pp. 523-4) marks the extent to which the verbal text functions not just as words, but also as signs of images and how logos sign beyond any lexical, grammatical or syntactic function.

6 American women and the American perfume industry do not have this *savoir*. This is obvious in one of the gimmicks whereby the advertisers include sniff-strips in magazine ads

or billing inserts. For the French woman a perfume odor strip is an abomination. The only way to test the product is by having it sprayed on in a store and then to wait at least an hour before smelling the complete chemical reaction with her body. What is more, recently, bourgeois American women have been blending their own concoctions of famous brands. For theAmerican, it is a mark of individuality and good "scents"; for the French woman, such mixing is a travesty of age-old and time-tested cultural knowledge found in the bottle and label.

There is, however, a much deeper cultural notion operative here. MacCannell notes well that sexuality leading to coitus is never the image proposed in American advertising because actual bio-reproductive sex is *not* the desired outcome (p.527-8). In France, sex for sex is desirable but with a difference: sex in marriage is for reproduction, sex for sexuality lies outside marriage and is a part of the whole art of seduction. Even within marriage, nowadays, sex is sought after for both pleasure and reproduction: the government continues to promote population growth of the French citizenry. The vast difference between cultural notions of sexuality is remarkable in another advertising campaign: in France, AIDS protection ads in magazines include foil-wrapped condoms.

7 The "drugged" female in American Guess ads is commented upon in MacCannell (op.cit., p.528).

8 Verba and Camden in "Writing with Flesh: A Semiotic Interpretation of Research Findings on Body Image Attitudes and Behaviors in the U.S." (*Marketing and Semiotics*, op.cit., pp.165-186) have set up a Greimasian semiotic square that relates food consumption, control and social worth which they later relate, via Octavio Paz, to sexuality and Puritanism in American imaging.

9 MacCannell puts this mechanism which operates identically for both the French and American scenes at a deep level as that of the repressed signifier, that "[a]dvertising functions to keep sexual desire alive outside of sex." (pp.528-29) so that the "unseen male" stays in a state of readiness for reproduction in the position of a view (or voyeur) just outside of the cultural frame." (p.530).

10 Stephen M. Verba and Carl Camden (op. cit.) bring to light also the avoidance-attraction of desire and guilt in marketing images.

11 American and French notions of friendship are also cultural barometers here. For the French, friendship is an important, time-tested relationship with very serious responsibilities. For Americans it is as prone to commodity-like "planned obsolescence" as any product that we discard after so many uses or when we make our every-four-year move. The French do not have American mobility, Americans do not have French stability. In France one can never say, "I met a new friend today." There are stages of growing intimacy from meeting to spending some time together to finally coming to one's home and thereafter becoming part of the family.

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12 See Chantal Cornuejols, "The Use of Advertisements from French Magazines in the Teaching of French as a Foreign Language" unpublished dissertation, University of Pittsburgh, 1990, section 5.5, pp.87-88.

13 The perfume ads we have discussed are found in upscale women's magazines in both countries where they vye to be located as close to the front as possible for the impact of first exposure. The magazines select the ads also for their seductive appeal: women frequently buy these magazines based on a quick skim of the first few pages. If they see images they may want to emulate or new trends to pick up, the magazine is purchased. Cigarette ads in the USA nowadays tend toward a lower profile. We found six cigarette ads in a lower middle class magazine, *Ladies Home Journal* (April 1991), with the preponderance toward the last third of the pages. The first ad, for Kent, is on page 60 of 233 pages after 28 other ads for do- it-yourself haircoloring and haircare products, inexpensive Revlon-like cosmetics, drugstore variety sun and skin care products, feminine hygiene products, home refurbishing articles, some clothing, and health and diet aids. The Kent ad glides in opposite an article on a famous star and curiously, the model of the ad, looks very much like Kevin Costner, the cover model about whom we are asked, "Is he as perfect as he seems?" and whose close-up is just about at the same proportions as the model's. Only very recently has French law restricted cigarette commercials. Winston has gotten around some regulations by advertising the Winston Way and Winston Lighters rather than cigarettes. Hence, they are found more toward the front of publications. The snob appeal of certain cigarettes, Benson and Hedges or foreign ones like Rothman, allow for their being showcased in better magazines and in the opening pages: they are not the dirty, cancerous, ordinary type of cigarettes. With respect to government regulation, it is also interesting to study the placement and phrasing of the surgeon general warnings. There is a series of statements that rarely get repeated in one issue; rather, the varying warnings are interspersed not just verbally but positionally as well, ranging from farthest corner to farthest corner. Hence the weight of the message and the status of the messenger get diluted and dispersed. But all this is another article.

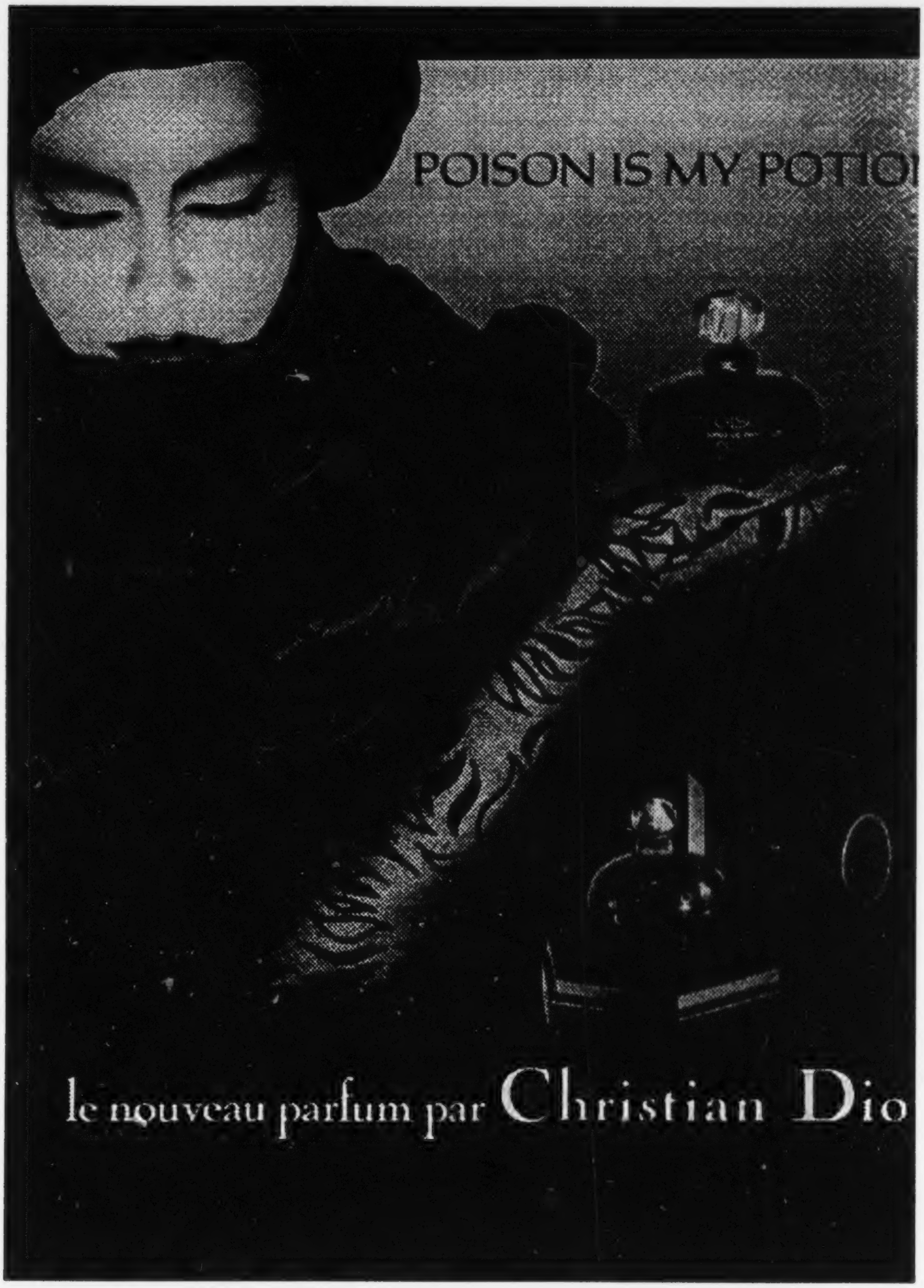

POISON IS MY POTIO
le nouveau parfum par Christian Dio

Illustration 1: American Dior Poison

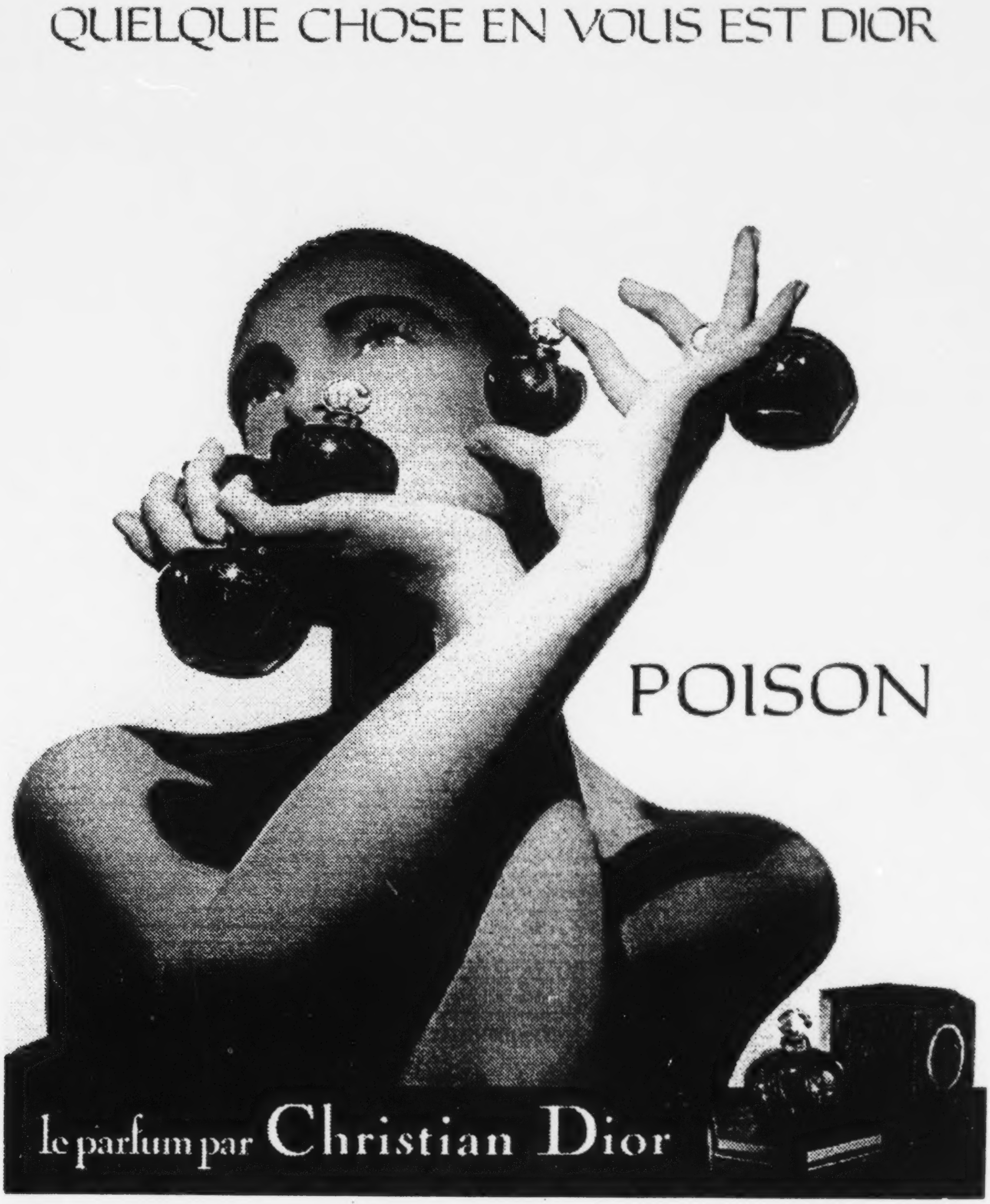

QUELQUE CHOSE EN VOUS EST DIOR
POISON
le parfum par Christian Dior

Illustration 2: French Dior Poison (old version)

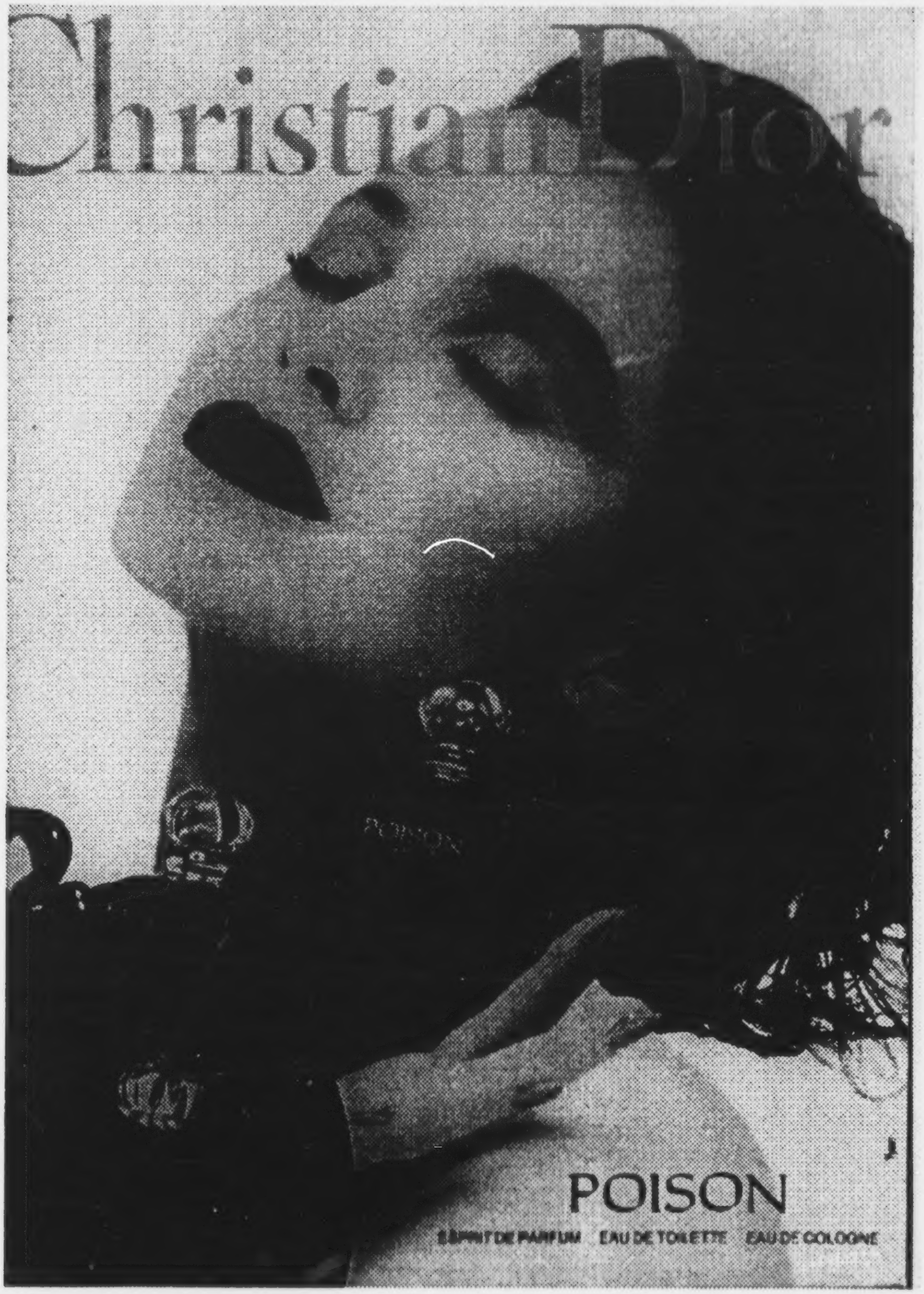

Christian Dior
POISON
POISON
ESPRIT DE PARFUM
EAU DE TOILETTE
EAU DE COLOGNE

Illustration 3: French Dior Poison (new)

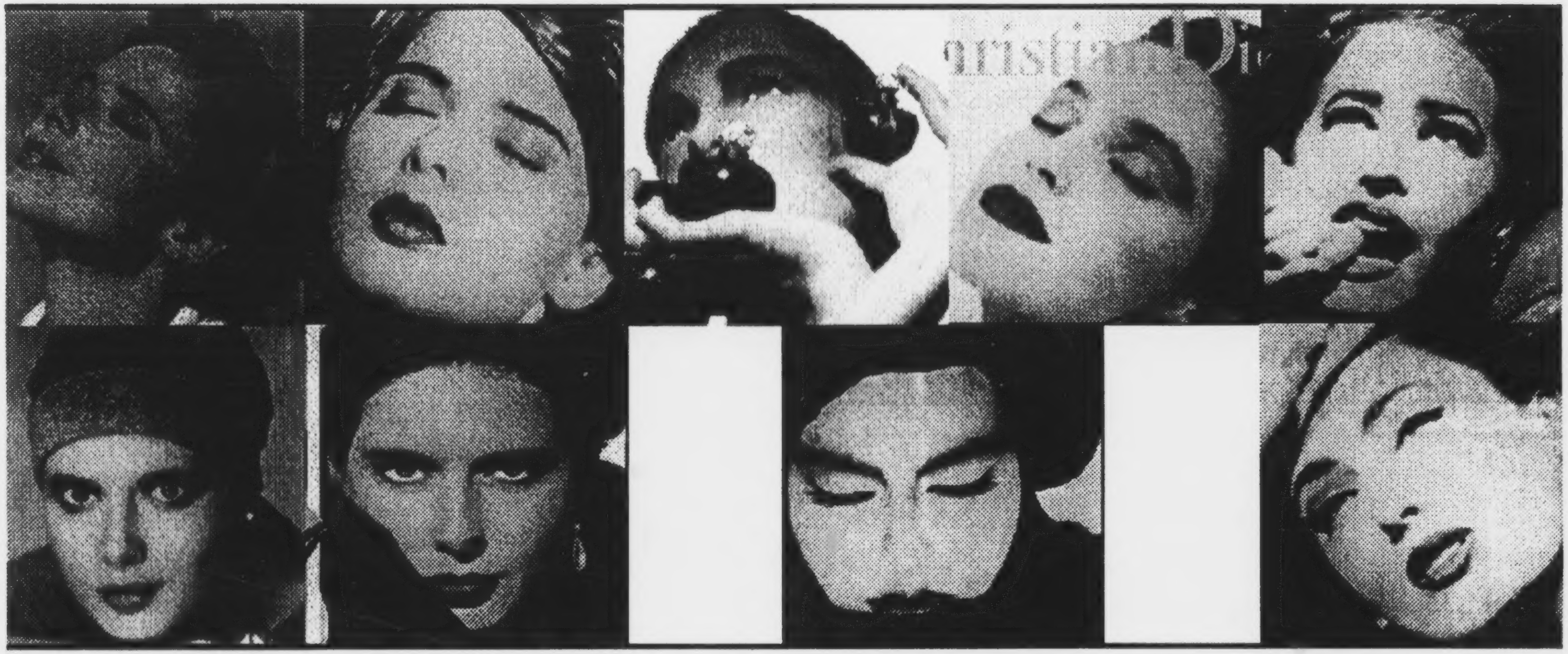


Illustration 4: top French, bottom American; R to L, Lancôme, Lancôme, Dior Poison, Smalto

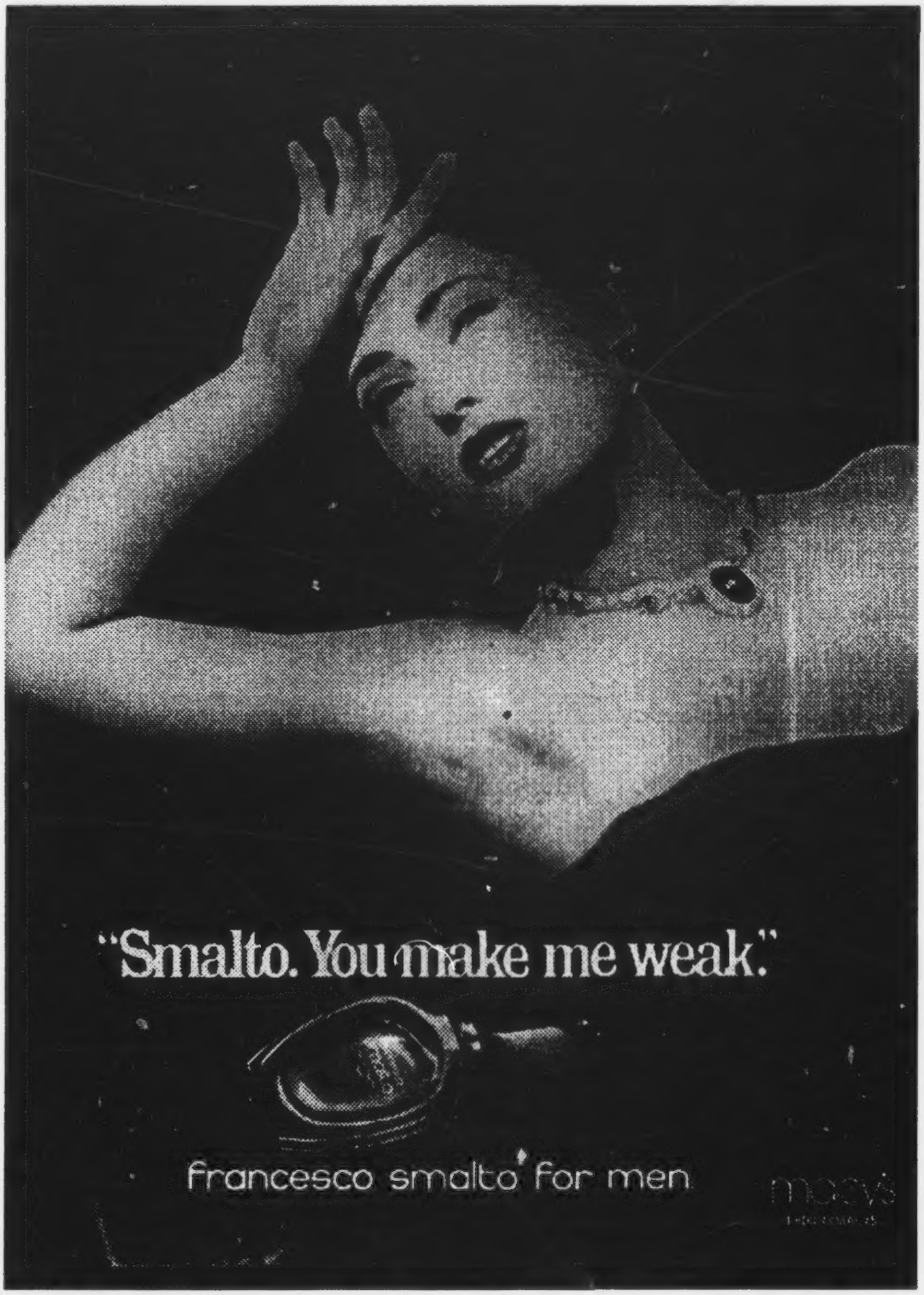

"Smalto. You make me weak."
francesco smalto for men
macy's

Illustration 5: American Smalto

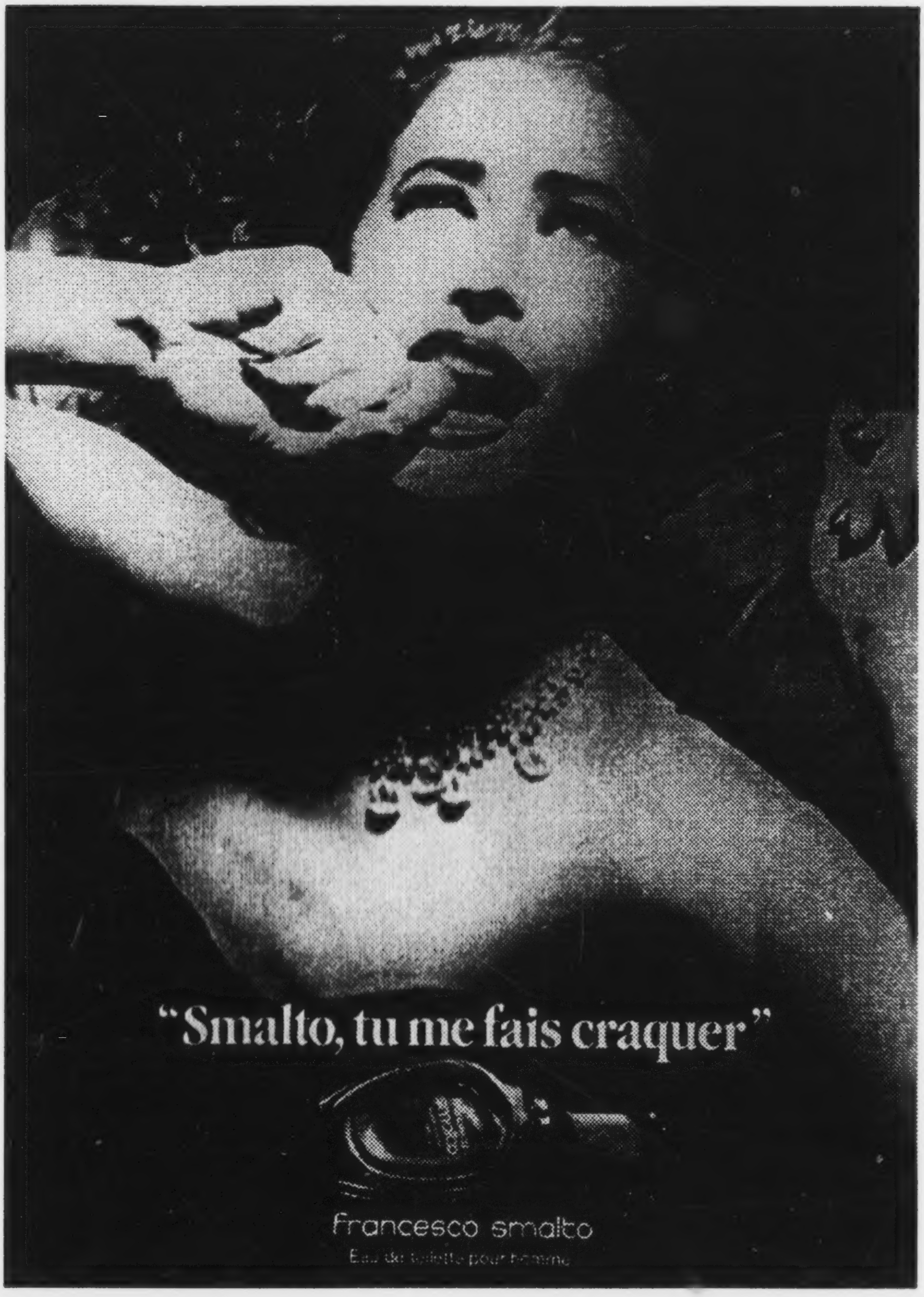

"Smalto, tu me fais craquer"
francesco smalto
Eau de toilette pour homme

Illustration 6: French Smalto

BEST COPY AVAILABLE

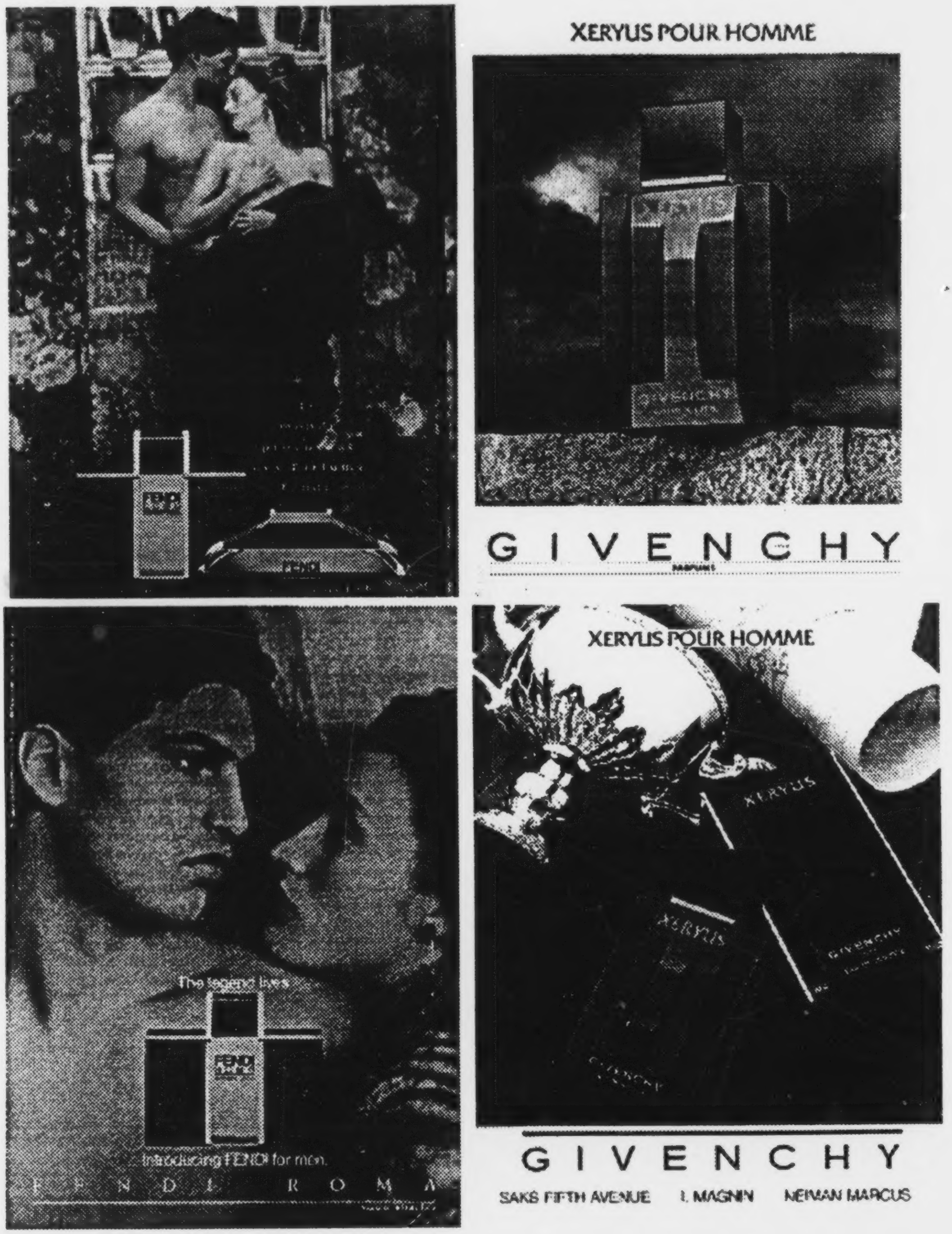

FENDI
XERYUS POUR HOMME
GIVENCHY
PARFUMS
The legend lives.
FENDI
Introducing FENDI for men.
FENDI ROMA
XERYUS POUR HOMME
XERYUS
XERYUS
GIVENCHY
GIVENCHY
SAKS FIFTH AVENUE
I. MAGNIN
NEIMAN MARCUS

Illustration 7: French & American Men's Perfume

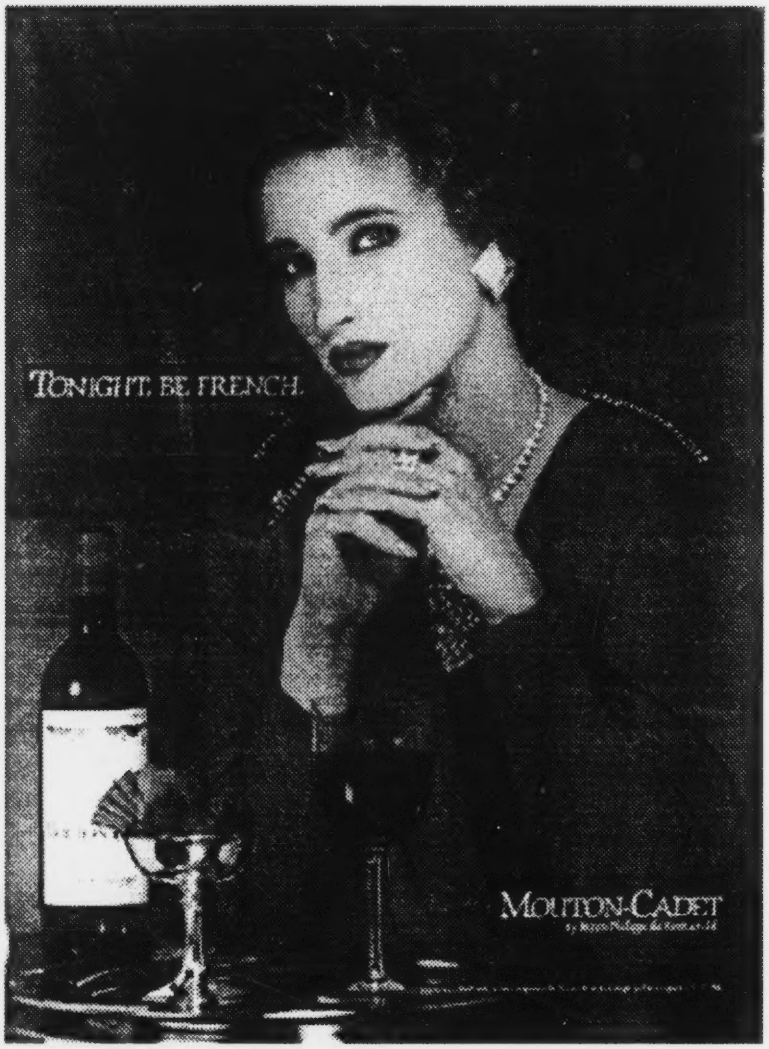

TONIGHT, BE FRENCH.
MOUTON-CADET

Illustration 8: Tonight Be French

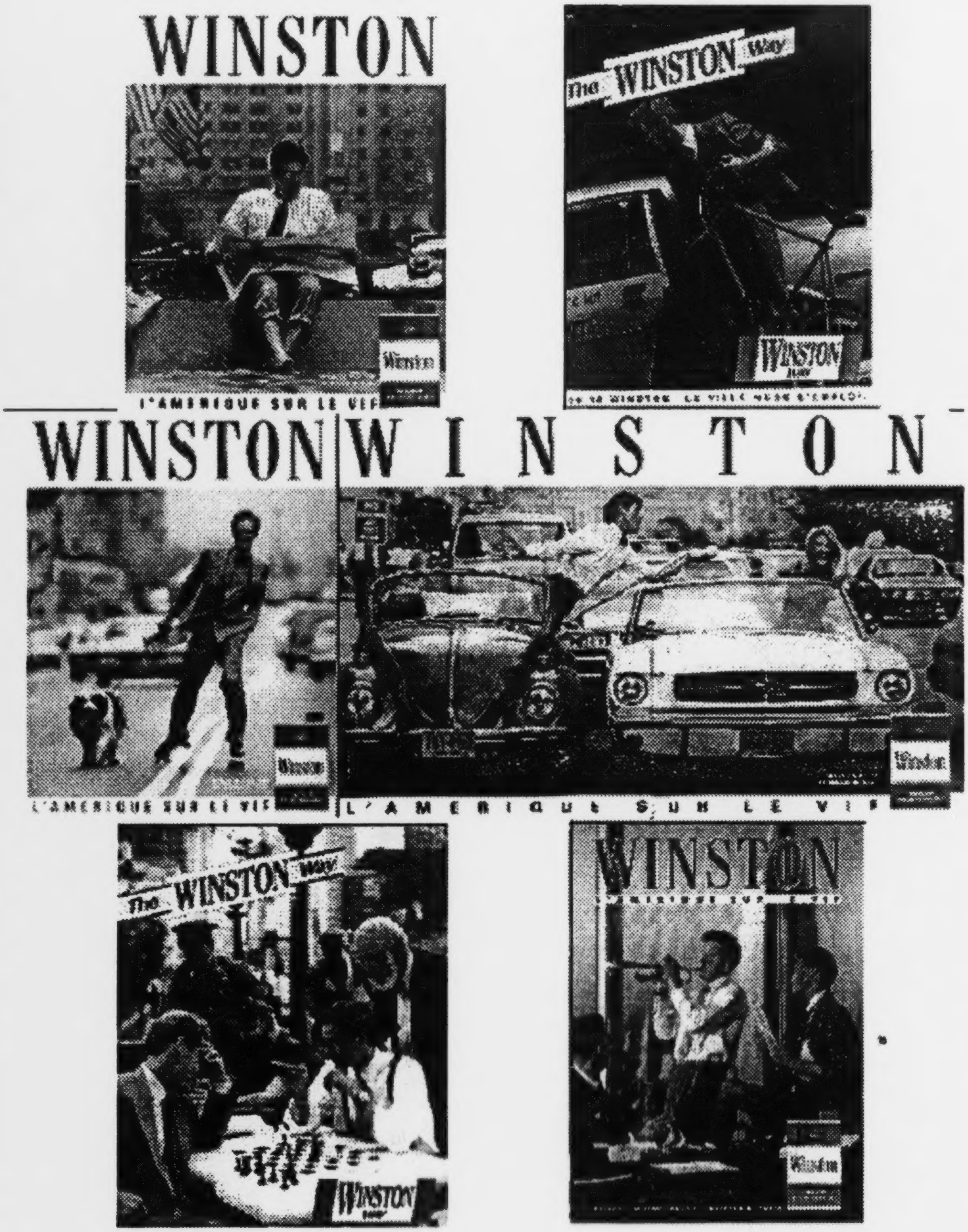
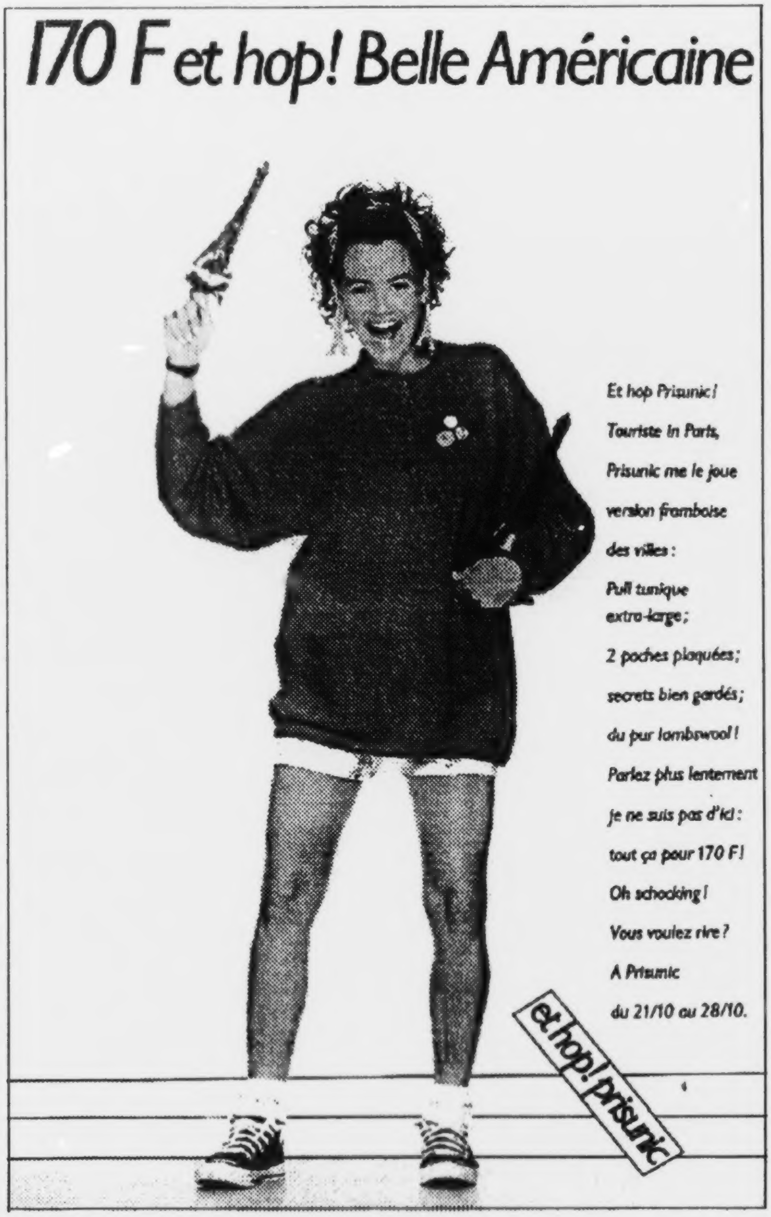

WINSTON
Winston
L'AMERIQUE SUR LE VIF
The WINSTON Way
WINSTON Way
WINSTON
Winston
L'AMERIQUE SUR LE VIF
WINSTON
Winston
L'AMERIQUE SUR LE VIF
The WINSTON Way
WINSTON Way
WINSTON
L'AMERIQUE SUR LE VIF
Winston

Illustration 9: Winston


170 F et hop! Belle Américaine
et hop! prisunic

Et hop Prisunic!
Touriste in Paris,
Prisunic me le joue
version framboise
des villes :
Pull tunique
extra-large ;
2 poches plaquées ;
secrets bien gardés ;
du pur lambswool!
Parlez plus lentement
je ne suis pas d'ici :
tout ça pour 170 F!
Oh schocking!
Vous voulez rire?
A Prisunic
du 21/10 au 28/10.

Illustration 10: la Belle Américaine

The Visual Thesaurus in a Hypermedia Environment:

A Preliminary Exploration of Conceptual Issues and Applications

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Visual thesauri and their applications to collection management incorporate a complex mix of political, economic and systems design issues. This paper describes and compares printed visual dictionaries and current state-of-the art visual retrieval systems. We critically examine the assumptions upon which such systems are constructed, and explore some ways in which images can be used in a text-free information system, and propose some areas here further inquiry is needed. We also present a prototype for a hypermedia visual thesaurus. Those who catalog objects are just now beginning to recognize the inadequacy of verbal language as a means of recording descriptive information on material culture or the physical world in general. The use of non-verbal representations has great potential to address the limitations of text-based taxonomies. The use of authority control and thesauri are an essentail part on any successful information sysem. In this paper, we have briefly described some of the implications of a similar process for visual media.

Introduction

In a recent article in *Leonardo*, Lawrence E. Murr and James B. Williams addressed the issue of visual versus textual information in education. Educators and librarians for centuries have relied on the printed and spoken word as the dominant method for transmitting knowledge. Information specialists have continued this trend by application of text-based information retrieval aids, such as index and thesaurus construction and keyword searching.

Murr and Williams discuss recent research into the brain's functioning which has led to the model of the left-brain right-brain dichotomy.[1] In this model different functions of cognitive processing are located primarily in the left or right hemispheres of the brain. The brain's left hemisphere seems to be linked to language processing, and is well-exercised by the overall emphasis on speech and text in education and in information systems. The brain's right hemisphere, which handles spatial reasoning, symbolic processing, and pictorial interpretation, has been ignored or at best has received much less attention in system design. Only recently have researchers begun exploring such concepts as "navigation" (a right-brain function) in information systems.

The development of cinema and later television and the present-day expansion of consumer electronics with the VCR and camcorder have made it obvious that people have a strong affinity for images. With the development of graphical interfaces and the rapid integration of computer technology with image storage media such as the video laser disc, textual representation no longer has to be the dominant paradigm in education or information retrieval.

The current emphasis on text needs to be balanced by increasing attention to graphic formats and visual interfaces. Many current information systems used to access images simply transfer the text-based methods of information storage and retrieval to computerized systems. Because the multiple aspects of visual access to images has long been neglected its development is still woefully inadequate. As statistical computer methods for image retrieval become more powerful a new emphasis on research in the multiple aspects of visual retrieval are needed. The interrelationships between text and graphics need to be thoroughly explored, as does the creative possibilities in visual-based retrieval systems. At present more and more powerful computerized retrieval systems are being developed that, according to the left-brain/right-brain model, still use only half of the processing power of the human brain. Additionally, learning research shows there are many different ways in which human beings learn; text-based methods fail to develop all but a few of these.

Visual thesauri and their applications to the museum community incorporate a complex mix of political, economic and systems design issues. In this paper we describe and compare printed visual dictionaries and current state-of-the art visual retrieval systems, critically examine the assumptions upon which such systems are constructed, explore some of the ways images can be used in text-free information systems, and propose areas for further inquiry. We looked at systems which utilized images as an aid in information retrieval, and discuss three that we feel are representative.

We are presently engaged in the development of a prototype visual retrieval system which will allow further exploration of conceptual issues presented here. The system, operating in a limited domain for which a visual dictionary already exists, allows manipulation of the visual object as a search mechanism, as well as the traditional textual access points. The domain chosen for this project is leaf identification.

We begin with some background material on images and image processing in general.

Human Image Processing

Reed discusses a variety of evidence suggesting that visual images and visual codes play an important role in human ability to perform many cognitive tasks.[2] Images preserve the spatial relations among objects in a scene or the features of a pattern. Experiments have shown that people can use either a visual code or a verbal code to retrieve information; the choice is dependent on the nature of the task. When a task emphasizes spatial information, people can scan an image in a manner which preserves the spatial information. In contrast, if the task requires the retrieval of verbal information, scanning a list associated with spatial information but ignoring it, is more efficient.

More importantly for information retrieval, visual images make it possible to simultaneously compare all the features of two patterns. Therefore information is matched in parallel. This is in contrast to features described verbally which are not all accessible at the same time and must be compared serially. Matching has been demonstrated to be relatively fast and independent of the number of relevant features only when the initial item is a pattern, and not a verbal description.

Visual images also make possible mental rotation of patterns until both have the same orientation. It has been demonstrated that time to match two images differing in orientation increases linearly with the number of degrees by which they differ. A computer can rotate images, often much faster than the brain can, thus they have the potential to facilitate the process of visual pattern matching.

Visual images play an important part in memory and learning. Research has shown that people remember pictures better than concrete words, and concrete words better than abstract words. Similarly, the formation of a visual image is much easier for concrete material than for abstract material. Words vary in how easily they can be translated into images however, and the successful use of imagery depends somewhat on the nature of the material that has to be learned. The imagery potential of words is a more reliable predictor of learning than the association potential of words. High-imagery words are easier to learn than low- imagery words, but high association words are not necessarily easier to learn than low-association words. Even when subjects are told not to use imagery, high-imagery words are easier to recall than low-imagery words. This suggests that people spontaneously generate images whenever they can. Dual-coding theory explains the usefulness of visual imagery in recall by suggesting that a visual image provides an extra memory code which is independent from the verbal code.

Current research has supported several of the long-standing rules-of-thumb concerning use of images as memory aids. Images need to be of a certain size to be effective, and the use of distinctive images and loci are important. There are several limitations to the use of visual images as memory codes. While a person may be able to visualize an image, the retention of details is more problematic, and suggests that visual images may be incomplete, and at least partially based on expectations or schema. Other results from tests requiring the identification of parts of a pattern indicate that most retained images are highly structured, somewhat vague, and difficult to reorganize. While visual imagery may not be appropriate for every task, the knowledge that people use visual as well as verbal codes to organize information deserves wider recognition and further research into how these processes could be capitalized upon in information retrieval generally, and in image retrieval specifically.

Museums and Images

Artifacts, objects, and material culture are the purview of museums, which classify and store their collections, as well as to make them available to scholars and the general public for education, enrichment, or research. At present, collection management tools used by the museum community rely on textual representations, while treating visual information or representations of objects as secondary. Collection management systems are not designed to deal with images as primary sources and so reinforce a text-oriented way of thinking about information retrieval. This includes but is not limited to, the interpretation of what the object is about, and what information carries the "aboutness" present in the object or its visual representation. Disciplines such as art and archaeology, which are actively involved with developing indexing and classification schemes for physical objects, are a source for detailed discussions on the problems and possible ways of indexing visual media. Even in non-object oriented fields the difficulty of developing non-ambiguous, consistently applied subjects and descriptive terms is widely recognized.

There is no universally accepted taxonomy, subject authority, or vocabulary for describing material culture. While over the last ten years several projects, such as the Art & Architecture Thesaurus (AAT) and Chenhall's Nomenclature, have developed hierarchical lists of descriptive terms, individual curators, archivists and librarians continue to develop their own indexing vocabulary and syntax. Standardization among systems which do exist is increasing, but, the characteristics of "aboutness" across and within institutional catalogs remain inconsistent and often difficult to determine. There are a number of problems associated with this approach, not the least of which is the difficulty a naive user has in easily accessing images, and that subject terms may influence subsequent interpretation of the image.

Karen Markey has described current access methods for collections of visual images.[3] She found that visual collections are accessible primarily by secondary subject matter, the overall theme or concept expressed by the image (such as *Madonna and Child*), rather than primary subject matter (the actual objects comprising the overall image). A major problem with this type of access is the unpredictable loss of a great deal of information about the image. Markey suggests the use of primary subject matter, a listing of preiconographical descriptors in an alphabetical, keyword in context format. This is the approach of the *Library of Congress Thesaurus for Graphic Materials: Topical Terms for Subject Access*, (Betz). Yet even this way preserves the inconsistencies of word meaning and problems of synonymy found in any text-based indexing system, in large part due to human error.

In a review of the literature on index creation for visual databases, one of the points mentioned time and again was a desire for a flexible search mechanism which would allow the addition of special visually oriented search capabilities,[4] a feature which is currently not possible with the MARC record format for pictures. This **implies** that there are considerable limitations for those attempting to create an indexing system for images which will address the needs of users in a MARC based system.

The ability to access and analyze information about compositional and technical similarities is important.[5] For users of an imagebase, information about color, texture, and light may be critical. End users may want to search using descriptive terms like "bright red," "cityscape," "cows," and so on. Drawing interpretative relationships between and within images is presently a human task. The user's interpretation of content shares with the indexers assignment of subject terms an individual orientation and therefore, a lack of standards and consistent application of terms. This matter is further complicated by levels of representation. A clock for instance might represent time to one user and an example of a type to another.

Inconsistent application of terminology is a thorny problem for all fields concerned with classification or indexing of objects. Several recent articles have empirically studied error in archaeological classification. Fish looked at the classification of both typologies and attributes and found that personal bias can play a part.[6] Beck and Jones found that systematic error is introduced into the classification of archaeological objects in three ways:

1) Variation in the explicitness with which attributes are described and definitions are applied;
2) Differences among different analyst's perceptions; and
3) Changes in an analyst's perceptions over time. Bias can also be introduced during data collection.[7]

These same types of problems occur in assignment of index terms to document and object and image records.

There has also been a lack of concern with indexing of images in print- based materials. Few back-of-the-book indexes (with the exception of art books) contain references to graphic materials contained within the text.[8] **Preliminary research has shown that images play an important part in the search process in both print and online formats.[9] Therefore, for an information retrieval system which includes graphical materials as well as text, the adoption of standard indexing and retrieval methods will result in far less retrieval precision for images and, indeed, can hamper the information retrieval process for both images and text.**

These findings suggest that it would be profitable to explore retrieval methods for images in computerized information systems in addition to textual indexing and thesaurus construction. **Computerized analysis and retrieval of images could offer both the needed flexibility and the consistency of application required in searching an image database.**

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Visual Thesauri and Scope Defined

For the purposes of this paper, we will define visual thesauri as *collections of images in a hypermedia environment*, as opposed to a collection of images in a printed visual dictionary such as *The Facts on File Visual Dictionary*. A thesaurus originally simply meant a "storehouse" or "repository, as of words or knowledge." Peter Mark Roget published a list of words in 1859 that he categorized as synonyms, antonyms, or related words. Because of the great utility of his work the word *thesaurus* has come to be associated not only with a textual storehouse but one which, by its organization, reveals pre-defined structures and relationships among concepts.

For the user, the visual thesaurus in a hypermedia environment differs from its printed counterpart, a visual dictionary, primarily in its ability to skirt hierarchical term associations, its lack of reliance on textual indexing, its independence from a particular taxonomy, and its end-user orientation. Hypermedia gives us the opportunity to reformulate the current structure of the text-based thesaurus from a unified normative taxonomy to one less dependent on predefined rules about relationships presented in a textual hierarchy. Take the example of a search for images of woman and children. An initial search returns a set of images including a few WPA photographs and a painting of the *Modonna and Child*. The user is interested in the statement made by the above named painting where a baby sits on a woman's lap. Rather then having to formulate a verbal query to match this need, the user outlines the major figure and asks for similar images in terms of subject content. With the basic visual message clarified, the searcher can use text to determine media [painting, photograph, tapestry], time period [14th century, contemporary], and cultural or social factors [mother and child, wealthy or impoverished].

We propose a hypermedia visual thesaurus that would support browsing and searching by means of direct image <-> image links, without the use of text as a preliminary or intermediate retrieval device. Such a system could also offer the user the flexibility of combining several different search mechanisms, both text- and image-based, in any order. To reach this objective, the system must be able to identify the "relevant" semantic parts of an image. To do so we need to exmain the relations between verbal and visual language, what part visual information plays in problem-solving, and what types or kinds of information are best communicated visually.

Analysis of Printed Visual Dictionaries

The relationship of graphics to text can be explored through a tool which has existed for centuries: the 'visual dictionary.' The purpose of a visual dictionary is to enable a user to find a name for an item whose name is unknown. It also enables a user to find a picture of an item whose name is known, or the name of a part of some known item (for instance, the signature of a book).

In 1672, Joh. Amos Commenius's *Visible World, or, A Picture and Nomenclatura of all the Chief Things That are in the World* was published in London. Since then many pictorial guides, visual dictionaries, encyclopedias, or indexes on a wide variety of topics have been created. Notable are: The *Oxford-Dudun Pictorial English Dictionary* (Phelby 1981); *The Stoddart Visual Dictionary* (Corbeil, 1989); and *Peterson's Field Guide to Bird Identification* (Houghton Mifflin, 1990). For the sake of convenience we label all of these "visual dictionaries." The editors of these visual dictionaries have defined their users primarily as non-specialists, the average person: "active members of modern industrial society who need to be acquainted with a wide range of technical terms."[10]

A visual dictionary is distinguished from an online visual thesaurus in that, in print form, there is an explicit structure imposed on the information, much as a regular dictionary has structure imposed by the alphabetical ordering of terms. The structure of a visual dictionary is determined by a process which includes selection of major themes (Transportation) and further subdivision of these into categories (Transportation by Railroad) and subcategories (coach car, sleeping car, dining car). Further categorization is determined by the association of items on a page with one another, as when stone is depicted with bricks, concrete blocks, and steel, all building materials. Thus, stone in this case becomes a "building material".

Access to information takes place in one of several ways. The user can locate an item for which the name is unknown using finding aids provided such as the table of contents or thematic indexes and browsing the sections until the item is identified visually, with its accompanying terminology. Alternatively, the user can browse the dictionary without consulting finding aids. When the name of an item is known the various indexes can be used to find the picture.

Within the broad thematic sections of the dictionaries, items on a page typically exhibit two types of relationships: part-whole, and similarity. Items are similar because of similar form or function or because they belong to a particular class as determined by an existing taxonomy. The two types of relationships may appear on the same page. In many cases composite or idealized objects may be used, eliminating details while retaining enough information to present an unambiguous picture. Within thematic sections, pages of related objects are displayed. For instance, 'house furniture' can include items such as dishes, lights, curtains and curtain rods, and domestic appliances as well as tables, chairs, etc. Thematic sections also bear a relationship to one another: clothing, personal adornment, and personal articles follow each other, as do architecture, house, and house furniture (see, for instance, Corbeil, 1986).

In visual dictionaries which serve as identification aids for natural objects or the animal world, color becomes an important identifying characteristic and may be the primary initial access point, as in a book concerned with wildflower identification. In addition, other more abstract concepts, such as seasonal variation and geographical location, become important facets of the object.

However, if an item is totally unknown and the user is completely unable to place it in relation to some category such as transportation, cooking, or Finches, the only access is to browse the pictures in the dictionary. Visual dictionaries exhibit an advantage over online visual thesauri in this respect; it is relatively quick and easy to browse the pages of a visual dictionary, even though the book itself may have a large number of pages. In addition, the relationship of an object to other objects on the same page or on nearby pages is quickly and easily grasped.

This type of browsing is difficult in an online environment. Even when a number of objects are displayed on a computer screen, rapid traversal of such displays is difficult in all but the most advanced experimental systems. The user also has more difficulty maintaining knowledge of the underlying organizational structure. In a print dictionary it is much easier to grasp the fact that images of clothing, accessories, and personal articles are in approximately the second quarter of the book and near objects associated with "home;" this spatial knowledge of intellectual structure facilitates both browsing and more structured search behavior.[11] What is lost to the user is the ease of determining that underlying structure, which becomes quickly apparent with the use of a print dictionary. Various methods (maps and webs) for reducing this disorientation have been explored, yet these remain less than satisfactory.

The print thesauri examined for this research failed in some of their stated goals; they also exhibited, in the selections and labeling of associated images, some of the problems found in indexing term assignment. One stated goal was "to assign to an illustration the role played by the written definition in a conventional dictionary"[12] yet this is only partially realized. For instance, the conventional dictionary definition of a 'shovel' is "an implement consisting of a broad blade or scoop attached to a handle, used for taking up and removing loose matter, as earth, snow, coal, etc."[13] This definition describes both the form and function of a shovel. In the visual dictionary a shovel is found in two places: with Firetending Tools; and Gardening: tools and equipment. Use is implied by the larger category and by the surrounding implements on a page, but is not specified. It is more clear in the gardening context as shovel appears with rake, hoe, etc., but in Firetending it appears with a broom, poker, log tongs, on the same page as a woodstove, with a fireplace on the opposite page. The visual dictionaries reviewed all assumed a Western orientation. While one dictionary included developing countries in its list of intended user groups, much of the information found therein remained inaccessible to these users.

With these information tools, indexing terminology has been determined by 'experts' and are generally accepted as authoritative. However, no single vocabulary can cover the range of possible intended uses or interpretations of meaning. Classification schemes based on expert knowledge cannot escape cultural influences, nor can they overcome the effects of time, or terminology variations between subject domains -- the very boundaries of which are dynamic. These visual dictionaries are not user-oriented because the reader must approach from the point of view of the expert whose view is represented. Published visual dictionaries work best when the reader conforms to the tacit assumptions made by the its authors.

Existing Visual Thesauri in a Hypermedia Environment

Ximagequery

Description

Howard Besser's Ximagequery is a system for locating images in one or more collections. The search process is facilitated by the presentation of search operators in one window, a thesaurus or authority file in another window, and the surrogate images. One can identify and click on terms and search parameters at will. The user need not type to construct a search query and can confidently work knowing that they are using acceptable terms. The linking between the search terms, the images and the catalog record incorporate a number of useful functions. For example, as one browses the surrogate images, relevant information in all the windows is highlighted and updated to keep current with the user's selection. A search is initiated using index terms to build a set of images, which are then available for browsing. The user searches the database using boolean logic or partial match strategies. Once the set is retrieved the user may browse up to twenty-four small surrogate images at one time. The surrogate images offer an alternative to the verbal description also provided. Any image can be enlarged on the screen for a closer look, and compared to another enlarged image.

Another feature of Ximagequery is the "map" which graphically represents the angles and location of visual media, in relation to some subject matter in a larger context. For example, photographs from a geological site have been indexed on a map with small camera icons indicating the location and angle of the image. By clicking on one of these camera icons one can bring up the associated image.

Ximagequery is not limited to searching one collection or domain. It has the potential to concurrently search a number of collections and retrieve images from these holdings. The quality of such a search is dependent on the linking between controlled vocabularies. Besser's intent is to have his system provide "a uniform user interface to different collections, yet allow each collection to maintain its own set of descriptive and indexing terms; the "look and feel" of searching remains the same, but the searching and descriptive terminology used changes for each collection."[14] For collections of images dealing with archeology, painting, and fashion different sets of indexing terms could be used, such as AAT and Chenhall's Nomenclature. Because Ximagequery is designed for an academic community, which is traditionally oriented towards literature, (i.e. texts) users working without a foundation in subject matter and online systems may find Ximagequery less satisfactory to use.

Analysis

Ximagequery is the marriage of a standard text-oriented online library catalog with a powerful image browsing mechanism. It allows the user to browse digital images without direct intervention by library personnel and without having to thumb through the physical images themselves. When designing this system, Besser's principal concerns were the wear and tear on images during physical browsing, saving personnel costs related to serving the user, and creating greater flexibility during the search process by providing a more dynamic search environment. These three objectives have been met in the interactive hypermedia environment of Ximagequery.

While Ximagequery is an excellent system, it is based on several important assumptions that need to be considered. One is the distinction drawn between image and text, another is about the author's intention. There is no clear distinction between the image as a work in itself, a visual representation, or a copy of a copy [slide of a photograph, e.g.]. It seems to us that Besser is talking mostly about the media through which the user encounters the item, and not some inherent quality of the item itself. According to him, with the written text, knowledge representation can be obvious even explicit; the author's intention can be known. With images representation is interpretive and textual.

NASA Visual Thesaurus

Description

The NASA Visual Thesaurus is based on Project ICON located at the University of Texas, Austin.[15] The project deals with the automation of image management in an academic or large institutional environment. Its primary focus is the automation of image cataloging, and the image retrieval processes. Of particular interest to us is their work on the substitutability of images for textual descriptions in an image retrieval system.[16] It was this line of inquiry that lead project researchers to the idea of a "visual thesaurus" as an aid to all users of the system, catalogers and searcher's alike. The NASA Visual Thesaurus functions much like a traditional text-based thesaurus in that it provides the user with related, broader and narrower terms along with corresponding digitized images.

This system links two separate but parallel thesauri, one verbal and other visual. The coupling of these is invisible to the user who is free to search either by text or image. Both hierarchies are presented together in a single user interface designed to illustrate the relationships between visual and textual representations. The objective being to offer a 'flexible alternative' for cataloging and searching the database, one that allows structured searches based on either images or terms, or by browsing the term or visual thesauri sequentially.

What the user initially sees is a main screen with three alternatives: "programs", "facilities", and "personnel." Each category is represented by a verbal term and by an image. One also has the option of going directly to the Term Index. The thesauri are operational at the main screen selection. After making an initial selection the user proceeds by choosing images or terms to narrow or broaden their search. After entering a term or clicking an image, the system responds with related, broader and narrower terms and any corresponding digitized images. The image or term once selected becomes part of the search query applied against the full database. Searching the NASA Visual Thesaurus is interactive. The results of a search are presented as both text and image. The visual representation is said to disambiguate the term assignment. The term thesauri is the authority source.

The visual interface masks the text-oriented retrieval system which constructs data sets based on statistically derived weighted values. The Visual Thesaurus does not use boolean search logic. Its visual interface is independent of the data retrieval mechanism used to search the imagebase. It was hoped that such an interface would not be hardware and operating system specific and might be used in a variety of situations present in the NASA environment.[17]

Analysis

Like Ximagequery, the NASA Visual Thesaurus functions as an interface to a large and rapidly growing collection. Undertakings such as The Athena Project (MIT) and Besser's work at The University of California at Berkeley (Ximagequery) have demonstrated that the technology is available to create image-oriented retrieval systems. The key issue is intellectual access not technological ability to present and manipulate images. If an image carries a great deal of information for the user which is dependent on contextual and situational factors, the assumption that meaning rests in a pre-defined set of subject terms is of limited utility to control access to the contents of an imagebase. Based on this finding, Rorvig, et al determined it was useful to construct "a visual thesaurus utilizing equivalent images... to duplicate the relationships established in the linguistic thesaurus."[18] These are presented together in a single user interface thereby giving a 'flexible alternative' to use image or text.

Rorvig describes two manifestations of what he calls substitutability.[19] The first is when a set of images is already conjoined with textual descriptions. The task then becomes to match the images to the existing textual descriptions. Rorvig resolves this situation via a "term association matrix" from which hierarchies are established. The image which has the statistically best representative characteristics becomes the image shown to the viewer. The second situation is for items in a visual collection which can be described by a small number of broad terms. Here the objective is to find the "best match between 'image exemplars' and each broad class." This situation, he argues, does not respond well to statistical methods. Instead, Rorvig has used a psychometric method to match representative images to broad classes. Part of Rorvig's contribution to dealing with image-text relations in system terms is methodological -- by establishing a general set of procedures to assign terms.[20]

We agree with Rorvig and his colleagues that the difficulties of matching the available languages to the richness of images is an intellectual problem that needs to be "overcome" to advance image retrieval. To begin to get at the visual contents of things, Rorvig wants his system to enable us to search by the "language of the image."[21] Like in the indexing of textual documents, the verbal descriptors available to describe the visual content of the image are often inadequate to express meaning from the user's point of view. Rorvig observes that in the case of images, the use of thesauri to control inconsistency is not effective due to the individual responses prevalent in human reactions to visual materials. We further posit that inconsistency is the reflection of creativity and the diversity of human interests, situations, and contexts. If inconsistency is to be "overcome" system designers will need to relinquish the idea of the utility of using 'words' to index 'non-verbal' understanding.

> Conclusions drawn from experiments testing the substitutability of images for textual descriptions of images in an image retrieval system suggest that human judgments obtained by exposure to images were more robust and more quickly obtained than those derived by exposure to textual descriptions.[22]

Ximagequery and the NASA Visual Thesaurus have significant distinctions and similarities. Both are text-based. Ximagequery is oriented toward the end user and towards preservation of the physical objects. In contrast, NASA Visual Thesaurus emphasizes the processing of new items in an systematic cost effective manner. Both use images to mask standard vocabulary control techniques. These systems enable the user to employ surrogate images to construct a search, but not through image-to-image links. In these systems text functions as an intermediary between the user and the data- or image-base. Seloff points out that most users of the NASA Visual Thesaurus are initially enamored with the ability to search using surrogate images, but do not always take advantage of the image-based retrieval functions. Overtime as users become more expert, they revert to the text-based retrieval functions. This suggests that there is more to designing image-based interfaces then presenting verbal expressions or visual surrogates.

The designers of the NASA Visual Thesaurus assume that there are important semantic links between images that cannot be verbally expressed. Besser does not seem to share this assumption. However, in neither system does one search by image-to-image links. Any benefit derived by having an image present is mediated by pre-coordinated text-based associations. The ability of the system to match the user's internal text or individual unbounded interpretations with a controlled vocabulary is yet to be resolved.

LEP Event Display

Description

Another example of a visual thesaurus is the event display system being developed at the Large Electron-Positron (LEP) Collider at CERN. This system captures massive amounts of data from thousands of detectors as beams of electrons and positrons collide. Each collision, or event, is instantly analyzed by a computer to determine whether or not it is "interesting". If it is, its data is recorded, otherwise the data is discarded. Randomly selected events are also recorded as a check on the algorithms that determine which events to capture. The data from these events are used to generate images which scientists then analyze visually. These displays can show the particles involved, there paths and their energies, as well as frames of reference, such as the structure of parts of the detector.

> By pointing to an object on a computer screen, physicists can call up specific information about that object. Thus, the image on the screen acts as an index to all the information gathered by the detector for an event.[23]

The ultimate purpose of this system is to allow human beings to see particles "that are trillions of times smaller than the eye can see and that move millions of times faster than the eye can follow."[24] The scientist, then, views the images that the computer generates from the data, looking for patterns and unexpected events.

Analysis

The LEP event display system comes closest to our idea of a visual thesaurus. The interface to the database is entirely based on images. The user views the images and, by selecting a portion of one, calls up another. It will be interesting to monitor the evolution of this system during the next few years.

Description of our Prototype

In an effort to explore the boundaries of the issues we_ve been discussing, we are developing a prototype visual thesaurus that will be image-driven to as great an extent as possible. We have chosen the domain of plant leaf identification. Similar domains to which our model could be applied deal with identification of objects or images such as artifacts, bones, fossils, pollen spores, coins, weather patterns, and the like.

Our primary interest is to reduce, or even eliminate, the role of text in the user interface. We want to create a system that allows the user to retrieve information without the use of keywords, descriptor terms, or the like. Rather, the user should be able to manipulate the image on the screen until it matches the object in hand, and thus formulate the query. The image is manipulated on the screen by using a mouse.

The first image that the user responds to is the basic leaf/leaflet shapes; i.e. narrow, elliptic, egg-shaped, oblong, etc. Once the basic shape is chosen a representative image is presented on the screen. The screen also displays an scale reference which is a human hand or portion thereof. A small image of a hand would be displayed alongside a large leaf (e.g. hickory) whereas perhaps an image of only a finger would be displayed with a very small leaflet (e.g. rose). The user is able to manipulate the attributes of the leaf, such as its size, margin, veination, lobes, and shape to best match the object-in-hand. This is accomplished through several mechanisms that have become quite common in CAD programs. The leaf image has "handles" at control points (nodes) that can be moved to adjust the shape. A control is provided to adjust the overall size, moving the control one way increased the size, the opposite way decreased it. Selecting the margin of the leaf reveals a palette of margins from which the user can choose. Selecting a vein or the petiole likewise produces palettes which allow the user to choose one that matches. The color of the leaf image is also adjustable by the user. The user can view either side of the leaf, and manipulate properties unique to the top or bottom.

As the user modifies the image to match her specimen, the system displays the number of likely matches. This allows the user to identify a highly unusual leaf with a minimum of effort by not having to adjust all aspects of the image before a single match is found. At any time the user can browse images of leaves that "match". The closest match appears in the center with the others radiating outwards in order of decreasing similarity. The user can navigate around this matrix of leaves or select any of these for further manipulation. Each leaf image also has associated with it images of a range map, fruit, and tree outline. Textual information (genus, species, etc.) can also be displayed for any leaf.

Analysis of the Problem

When considering information retrieval in general we are reminded of an old Russian proverb that goes something like: "If you know what you are looking for why are you looking, and if you do not know what you are looking for how can you find it." We are looking for alternative ways of image retrieval, ways that are less dependent on familiarity with existing taxonomies and their assigned authorities. Accomplishing this end is less clear-cut. When we began this line of research we vowed to answer existing questions and try to formulate the same questions anew -- we have done a bit of both. Based on our initial exploration of the idea of a visual thesaurus, a number of areas seem worth persuing both conceptual and technological. In this paper we have touched upon three categories related to the management of visual representations of objects. These are: human image processing, information retrieval and interpretation.and communication of meaning. These fall generally into the following categories: cognitive behavior; natural language in information retrieval; and ontology. In this section we will briefly review a few specific points, but issue a caution being that these domains overlap and are difficult to neatly package into descrete wholes.

Until recently the museum community, especially those who have traditionally dealt with paper documentation of material culture have built information systems for collections management similar to or meant to mimic traditional text-based finding aids. The online image retrieval systems largley do the same with the printed visual indexes. With this approach, knowledge or information is represented by a pre-coordinated set of terms. These systems do not allow the user (be they cataloger or patron) to address their information need or problem in a non-standard, i.e., visually oriented, way. We also found that access to visual information is similar to, if not based on, printed word dictionaries with their alphabetical arrangement; or visual dictionaries with either topical classification schemes or associations of objects such as part-whole or genus-species. These approaches we classified textual because they embody both verbal and linear knowledge representations.[25]

In visual retrieval, the important conceptual, or semantic, relationships include visual distinctions like "fatter" vs "thinner" and "shiny" vs "dull," or visual patterns that are easy to recognize but difficult to verbally express. It is our contention that these kinds of relationships do not necessarily have to be text-based, (and indeed, when they are, demonstrate the problems associated with the interpretive and contextual aspects of such values or qualities), but could be linked by visual cues and patterns and manipulated by means of graphical tools in an interactive system. In this paper, we have argued that modeling a computerized image retrieval system on traditional text-based visual dictionaries is problematic.

The shift from text-based to imaged-based retrieval brings require us to address questions. They include: how would or might people "use" images in an information system; can visual thesauri enhance retrieval when people cannot clearly articulate their information needs; what kind of balance is needed between the richness of an image and the simplification or abstraction used as an access key; what situations are suitable for visual retrieval; what criteria do we use to make these determinations? And finally, how do people relate visual representations of objects to their textual counterparts? Interface issues, such as page and document definition and navigation, and their accompanying visual cues, are crucial to successful navigation of these systems. And finally, what is the range of associations necessary to browse objects?

If we argue for a visual thesaurus we must acknowledge some degree of linguistic relations both within and between images. What is it in an image that carries meaning for the viewer? How might we parse images so that meaningful chunks could be articulated and used to match similar patterns found in other images? Is it constructive to develop visual thesauri whose semantic structure does not mirror a printed thesaurus in a related topic? Will the semantics of "visual language" offer more flexibility to the user?

Lets consider a landscape painting as an example. How might the narrative elements in such an image be encoded in a useful, i.e. open- ended, format? This simple question belays a complex of issues, such as what carries the meaning for the viewer? Is it painter's brush technique, the pallette, the iconographic references, the situation depicted, etc, etc. Clearly these values are affected by a variety of individual and cultural factors. One approach to his issue might be to create image-based systems that allow the user to identify and search on patterns. In this context, patterns become a high level vocabulary woven togehter to form a visual language. Possible advantages are less reliance on pre-coordination of terms, although the need for a visual vocabulary control is implied. Whether one is looking at a *Modonna and Child*, at a mother holding her baby, at a baby sitting on a woman's lap, and so on, with pattern matching locatation and identification of images carring similar messages for the user is a potential solution. In doing so perhaps the user will avoid stumbling over the complextites of disambiguatation of verbal expressions. In this instance, the user makes the final determination about which image suits his or her needs. This type of matching might be done with colors, textures, and other forms of visual cues.[26]

For visual dictionaries, the only access to unnamed items is visual recognition accomplished by browsing. In contrast, an online visual thesaurus could offer more flexible search strategies for object for which the user has now words. In addition to visual recognition, users could "assemble" an image for processing or preprocessing. In order to compensate for the lack of spatio-intellectual orientation such as occurs in print dictionaries, further visual clues could be provided to the user of these systems.

Questions related to information retrieval and cognition arose during our initial exploration of visual retrieval. We raise them here to provide our readers with a sense of the complexity of image retrieval in a world dominated by text. We hope that others will join in the investigation of these matters. To date, the majority of existing hypermedia systems are precoordinated, i.e., the user follows pathways or links that have been established in advance by the system's author. If two nodes are not connected (linked) a user will not be able to jump from one to the other. Yet jumping from one "node" of understanding to another previously unrelated node is the essence of problem solving and creativity. This type of linkage cannot be predetermined but must be generated "on-the-fly" through a cooperative effort of the user and the system. What are the limits of an interactive hypermedia system in these terms? To what extent are the problems different or the same as those for researchers in text- based systems? What level of visual complexity and what level of control over same should be presented to the user to facilitate searching?

Finally, we turn to the ontological realm. Visual dictionaries and thesauri harbor two commonly held assumptions about how people understand their experience of the physical world, how they communicate it to themselves and others. An important and significant trend in information studies is the shift from traditional search and retrieval of information objects, e.g., books and articles, to information as a value- added process.[27] That is, shifting from "information" as a noun to the verb "informing." In this context, there are two concepts of concern to us.

The first is a commonly held assumption about the distinction between an image and a text. This assumption posits texts as verbal presentations (written or spoken words) and images as non-verbal (graphic or pictoral representations or "real" or imigined worlds). This differentiation begins to crumble when viewed in non-system terms. For example, is a slide of an illuminated manuscript image or text? Are the hyroglyphics in the ancient Egyptian temples image or text?. Is an interpreation (reading) of the landscape of Vactian City image or text? It might be argued that whether what we preceive something as image or text depends on reader's persepective; that what is a text to one person maybe image to another. In most systems, the basic assumption related to providing access to pictorial or graphic images includes the tacit approval of the image - text dichotomy. What we mean by image and text has considerable repercussions for both theory and method of image retrieval. By treating visual and verbal texts as conceptual equals we have several theoretical and methodological advantages.[28] We can explore the linguistic relations between images as we would between texts. We can proceed on the assumption that image and text alike are part of the intertextual web of interpretative relations. We can spend less time trying to translate images into words, and more time thinking about how to represent visual tropes and other forms of visual language.

The second assumption, which is related to the image - text issue, is that a classification scheme can or ought to be "value-neutral?" Some people argue that meaning is culturally mediated, while the others argue for a reality fixed in time and where experience is a measure of a "natural order" of things. One manifestation of the latter viewpoint is the used of a pre-coordinated classification scheme. Information systems that are so designed transform intangible experience into tangible objects. This is the traditional and most common form of information system. For those who think that reality is a social construction, the concept of hypertext or hypermedia is appealing. The potential of limitless associations fits well with the pluralistic view of information seeking.[29] Images can, indeed should, play a central role in the dynamic information systems now being developed.

Conclusion

Those who catalog objects are just now beginning to recognize the inadequacy of verbal language as a means of recording descriptive information on material culture or the physical world in general. The use of non-verbal representations has great potential to redress the limitations of text-based taxonomies. One of the most successful approaches to library and archives automation has been through thesauri and authority control. In this paper, we have briefly described a similar process for visual media. Just as with textual descriptions, visual knowledge representation has multiple layers. The following table outlines the levels of complexity inherent in any information system dealing with visual information.

Funtions	Examples
Iconographic	A man in a suit and tie = establishment A "key" = St Peter
Sensory values	Color, texture, affective, emotional
Temporal and Spatial	Spatial relationships, perspective, change, cause and effect
Social / religious	Icons, personification, anthropomorphism
Object identification	Maker's marks, chops, styles, object characteristics, types and kinds
Visual tropes	Visual metaphors, allegory, simile, word play, word association [e.g., pitch fork to fork in the road]

Figure 1

The ability to call forth an image is not enough, not an end in itself. Additional 'functionality' is needed. What 'functions' do we want to consider? David Bearman has suggested the additional functions of, print the image, manipulate the image, view a prior or subsequent condition, and relate to data (or images) elsewhere in system.30 These functions assume one has found suitable images to manipulate, print and view. In addition to Bearman's suggestions we add: visual 'way-finding;' graphics-based information retrieval; and further clarification of the relations between graphics and text that is not systems oriented. We hope our explorations in this area will provide a basis for further research, and that many of the issues involved will be made explicit in the course of our research.

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17. Seloff, 690.

18. ibid., 687-88.

19. Rorvig, 1986

20. Rorvig, 1987

21. Rorvig, 1987, p 57. Adopted by Rorvig from a concept initially put forth by Lois Lunin.

22. Seloff, 687

23. Breuker, H. "Tracking and Imaging Elementary Particles", *Scientific American* August 1991, 63

24. ibid., 58.

25. An interesting aside pointed out by David Bearman deals with the phenomena of defining concepts in opposition. For example, clocks with hands only became "analog" following the introduction of digital clocks. Why the term analog was chosen is not clear. The same can be said of the relationship between linear and non-linear. "Non-linear " hypertext systems gave rise to linear systems. See David Bearman, "Implications of Interactive Digital Media for Visual Collections," *Visual Resources,* 5(1989):311-323.

26. Solutions to this questions may be helped along by current research in neural networks

27. Taylor, Robert, *Value-added Processes in Information Systems* Norwood: Ablex Pubs, 1986

28. This over simplification of a complex issue.is made for the purposes of this presentation.

29. There is yet another type of system in the objective - subjective debate. These focus on a narrow user community or domain. These are built upon a local knowledge base, consciously limiting variation, but covering the topic with the 'appropriate complexity.'

This type of information system has been classified as an expert system and has largely fallen into the arena of artificial intelligence.

30. Bearman, p 316

Full-Body Interactive Exhibits

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Introduction

In the late 1960s, I was a graduate student in Computer Science at the University of Wisconsin. Unlike my peers, with engineering degrees, I had a liberal arts background. Thus, while they were interested in the engineering efficiency of computer design and operation, I thought of the philosophical significance of the encounter between man and machine and in particular the problem of the computer-human interface.

Although my original goals were technical, I quicky realized that the scientific method was not appropriate for discovering the ideal design for this interface. Rather, the design of such an interface had an important aesthetic component. In its purest form, the interface between human and computer suggested a new art form based on composed interaction.

In 1969, I collaborated with a group of artists and technologists on an art and technology exhibit. When the artists resisted making interactivity the focus of the work, I vowed to create environments in which composed interaction was the primary goal. To see my vision of computer art realized, I would have to become the artist.

In 1970, I created an installation called METAPLAY which was an "experiment" in the old-fashioned, romantic sense of the word. Today, scientists always have to know the result that their experiments will yield before they apply for funding let alone run the experiment. In METAPLAY, I did an experiment to see what would happen. I wanted to discover the innate expectations of the technologically naive human. How could a person be induced to interact with a computer without verbal instruction?

I knew that I wanted to respond to a person's behavior using the computer. This desire implied that the computer would be able to perceive the participant's behavior. I had no idea how to achieve that in 1970. Therefore, I decided to fake it. Like the Wizard of Oz, I created my desired interface with smoke and mirrorsa bit of interactive theater. I used the only mechanism that I was aware of that could understand human behavior in real timemy own eyes.

People walked into the Union Gallery at the University of Wisconsin. They were confronted with a 8 foot by 10 foot rear-projection video screen that contained their own life-sized image. They saw grafitti being drawn on their image. I was sitting a mile away in the computer center drawing with a data tablet. My drawing appeared on an Adage vector graphic display. A video camera was aimed at the Adage screen and its signal was transmitted across campus to the gallery where it was superimposed on the live image and the resulting composite image was projected in front of the participants. In addition, the composite image was transmitted back to the computer center where it was displayed on a monitor that provided the feedback I needed to draw.

People were mildly entertained by the grafitti for a while. Then, they started to make the situation interactive. When they saw the cursor coming toward them, they would run away from it. They would bat it away as if it were alive. Based on that reaction, I changed the cursor from a cross to a circle which I placed at the top of the screen when people entered. Inevitably, someone wondered what would happen if they touched the image of the ball with the image of their hand. They would reach up and hit the ball. I would move it across the screen as if in response to their blow. Typically, a person on the other side of the screen would reach up to hit it back. I had people playing vollyball with a nonexistent ball in 1970.

Then, one day I was drawing something on a person's hand. He was embarrassed by the attention and moved his hand. I followed his hand with the pen. The result was that a line appeared on the screen. It looked as if he had drawn the line with his finger. He moved his finger again and I followed. After a moment of crudely successful drawing, the person next to him reached up and took the line away with his finger. We were able to lead thousands of participants to discover the drawing interaction without saying a word to them. This process was repeated ten hours a day, seven days a week, for six weeks. Many interactions were invented, revealing a set of expectations that were established by juxtaposing a person's image with a graphic object.

One day we were working on a technical problem. We were sending data from a sensory floor in the gallery to the graphics computer in the computer center. There was a problem in data transmission. We talked on the phone trying to identify the nature of the problem and then its source. It occurred to me that we had a better way of discussing our problem. I asked my colleague to display the information he was transmitting on the computer in the gallery, which had a limited graphic capability. Next, I had him aim the video camera at that computer's screen. The result was that the composite video image showed the data transmitted from the gallery computer at the top half of the screen and the data received by the computer center computer at the bottom half of the screen. As we discussed the composite image, it was natural for us to move our hands in front of our respective cameras to point at features we were discussing. It was just as if we were sitting together on the same side of a table talking about information on a piece of paper. The illusion of being together was compelling enough that when the image of my hand briefly overlapped the image of his, he moved his hand. I barely noticed the first time this happened. After several occurrences, I realized that he was unwilling to hold hands with me. Personal distance was being observed in this purely visual world.

Subsequent experimentation confirmed my suspicion. For most people, their image is an extension of themselves. What happens to their image, happens to them. What touches their image, they feel. Thus, I realized that I had stumbled onto a very important set of principles. While we usually think of telecommunication as being between two points, in METAPLAY, we had created a new place which consisted of the information that the two remote participants shared simultaneously. In the playful part of METAPLAY, one party communicated through computer graphics and the other communicated through physical gesture. In the serendipitous teleconference, we both used our hands and voices to interact. (I should acknowledge that the only reason that I had resorted to telecommunication in the first place was that the university would not let me move the graphics computer to the gallery.)

The ultimate extension of these concepts was the creation of a new telecommunication place that I dubbed VIDEOPLACE. One would enter VIDEOPLACE through an installation similar to that used in METAPLAY. Instead of being alone on the screen, your image would be joined by the images of other people who were in distant locations. The experience would be similar to METAPLAY, except that what had been accomplished with human intervention would instead be accomplished automatically by computer. To make the remote participants look like they were in a new place, the video image would include graphic scenery which would provide a context for their interaction. Since we had already discovered that people who see their images together, act like they are together, and that they expect something to happen when their images touch graphic objects, we decided to make that sense of touch effective. In VIDEOPLACE, when a person touches the image of another person or the image of a graphic object, the computer can detect that contact and respond to it in any imaginable way, including moving the object, making it disappear, changing its color, or causing it to emit a tone.

In addition, the participant's image can be subjected to forces that are not operating on his body. The computer can move, scale, and rotate the participant's live video image exactly as if it were a graphic object.[Figure 1] This movement can be in response to the participant's action, in response to the action of another participant or graphic creature, or at a scripted moment in the interaction. The result is that VIDEOPLACE is an artificial reality in which the laws of cause and effect are composed from moment to moment.

VIDEOPLACE was proposed as the theme of the US Bicentenniel. There were to be VIDEOPLACE installations at several locations in the US, Europe, and Japan. While VIDEOPLACE was obviously not implemented on such a global scale, it was an official Bicentenniel project. It did receive some funding from the National Endowment for the Arts, and a preliminary version of VIDEOPLACE was exhibited in the Milwaukee Art Museum in 1975.

In 1974, I began the construction of the VIDEOPLACE system. While no components from that era still exist, the system has been in constant operation since that period. It slowly metamorphoses from one technology to the next. The organic development of the system is unlike any technology project I am aware of. By the mid-1970's, VIDEOPLACE was capable of rudimentary operation. In the following decade, the system grew by accretion with the gradual improvement of its ability to understand what the participant standing in front of the camera was doing with respect to the graphic world. In the early 1980s, VIDEOPLACE had evolved to the point where it was capable of a wide range of interactions based on real-time understanding of the participant's behavior.

At the end of 1982, my 1974 dissertation appeared in book form as Artificial Reality (Addison-Wesley). It considered the technology and aesthetics of interactive media like VIDEOPLACE. It also forecasted the current goggle-and-glove technology as another way of accomplishing similar results.

In 1985, I went public with a paper describing working technology at the SIGCHI Conference (Computer-Human Interaction). Later that year, VIDEOPLACE was shown in the SIGGRAPH Art Show, also in San Francisco. The VIDEOPLACE exhibited at that time was a single-ended installation in which one or more people interacted with the computer. They stood before a neutral background of translucent plastic, backlit by fluorescent lights to provide a very high contrast image which enables the computer to distinguish the participant from the background.[Figure 2] This video image was thresholded and subjected to a two-dimensional filter to eliminate noise pixels. The resulting binary image is passed on to a series of specialized computers that operate in parallel to analyze the participant's sihouette in order to locate head, hands, torso, and fingers. These processors are thousands of times faster than a PC. Since they operate in parallel with the host computer, the elaborate perception algorithms exact no penalty from the performance of the system.

The resulting exhibit is not a single piece in the traditional artistic sense, but a new medium in which many interactive vignettes have been composed. Partly, this strategy is a matter of engineering efficiency. By having a single installation present 50 different experiences, VIDEOPLACE is intended as a celebration of the rich opportunity that interactivity offers us. From an artist's point of view, the variety of interactions can hold people's attention longer than any single painting or sculpture. From an exhibitors vantage, a single installation can be continually renewed with new compositions.

As an interactive artistic medium, artificial realities differ from earlier art in that the artist leaves the work unfinished. Its completion is provided by the unique behavior of each individual who interacts with it. This possibility confuses the identity of the artist. In the past, humanity could afford very little creative effort. Therefore, a few individuals were assigned the role of aesthetic specialists to do art for the rest of humanity who were too busy plowing the fields. However, today, it is appropriate to invite all individuals to quicken their aesthetic sensibilities, not to consume art as passive spectators, but to actively participate in its creation.

One class of VIDEOPLACE interactions pursues this goal. The participant enters the environment and finds that his movements create aesthetically pleasing patterns. He has been given a new art medium to play with. Since he does not recognize this medium as corresponding to any existing art form, he is not inhibited about exploring it. Therefore, he will often move his body motivated solely by aesthetic goals, even though aesthetics ordinarily would never guide his behavior. What is important is that the aesthetic experience is created by the person who will appreciate it. It is not created by one specialist to be critiqued by another specialist who will then instruct the public as to what they should like and why.

The most basic of this class of interactions was based on the METAPLAY drawing interaction. In DIGITAL DRAWING, you hold up your finger and the image of your finger draws on the screen.[Figure 3] It is liberating to be able to draw without touching anything. It is especially charming if you try to erase what you have drawn by rubbing your hand over it. The computer recognizes the gesture and erases the screen as if by magic. In a variation on this interaction, you can draw an invisible path that is continually traversed by flowing particles. By synchronizing your drawing movements with the flow of the particles, you can create a complex choreography of light. In related interactions, you can paint with your whole body or just your fingertips. You can create abstract geometric shapes or become an animated Mondrian painting. In a more sophisticated interaction, eight copies of your shrunken image are arranged on the screen in a circular pattern.[Figure 4] The dynamics of the resulting kaleidoscopic medium are so rich that it will often captivate an individual for an hour. The CRITTER interaction was the result of a tremendous effort. CRITTER is a simple computer-generated creature who perceives the participant's behavior and interacts with him in a playful way.[Figure 5] If the participant moves, CRITTER will chase him. If the participant holds out his hand, CRITTER will land on it. If the participant holds still, CRITTER will climb to the top of his head and do a little jig in celebration upon reaching the summit. It is also possible to get CRITTER to dangle from your finger. If you shake your finger, CRITTER will fall off and plunge to the bottom of the screen where it flattens as it strikes. After observing thousands of people attempting to capture CRITTER, we have made it possible. The first step is to surround it with your image. CRITTER will try to escape frantically. If the surrounding area is slowly constricted, it will explodeonly to be resurrected a moment later. CRITTER is a stand-in for artificial intelligence or, at least, artificial personality. It is a playful artificial entity that is so engaging that you forget that the creature you are playing with is not really there.

Another theme of the work has resulted from the manner in which it was originally developed. I thought of METAPLAY as a way of simulating a computer-human interface that I could not yet implement. Success would occur when I could replace myself by a computer. What really happened was that I had stumbled onto a superior conceptcomputer meditated human-to-human interaction. The computer was allowing me to interact with another person in a new way. I could establish a simple world in which two people in different locations could interact with each other. This was the first time that telecommunication was identified as a fundamental part of the artificial reality concept. The artistic opportunity was that the artist could define the circumstance in which two people would interact and could thus be a third party to their interaction.

Towards this goal, I connected the VIDEOPLACE environment with the VIDEODESK, which has an overhead camera aimed down at a seated person's hands as they rest upon a light table.[Figure 6] The image of the VIDEODESK participant's hands can then appear in a composite image that includes the VIDEOPLACE participant's full body. Either image can be moved, scaled, or rotated as a consequence of actions in the graphic world. The VIDEODESK participant controls the selection of response rules with her left hand. Since she has more knowledge and power that the VIDEOPLACE participant, her role is to facilitate a playful experience for the other participant. She is a benign Big Mother, as opposed to her tyrannical sibling.

She can join the other participant in any of the single-ended interactions, making them into cooperative aesthetic teleconferences. She can also take advantage of the juxtaposition of her image with the other participant's. There is a tension created when the two images touch. In one case, we take advantage of this by making a sound when the VIDEODESK participant's finger touches the image of the VIDEOPLACE participant. A different sound is made when the VIDEOPLACE participant touches her hands with his finger. Thus, while there is an embarrassment about touching, nothing happens unless one participant touches the other.

In another variation, the VIDEODESK hand reaches in and pushes the VIDEOPLACE participant's image across the screen. Seeing their image abused in this way usually leads the latter to push back. Often, a full scale fight ensues. Then, the VIDEODESK hand strikes the VIDEOPLACE participant's image in the head. The image is knocked down and pops back up againlike the inflatable children's toy with sand in the bottom.

In another case, the VIDEODESK hand extends a finger and a graphic string dangles from its tip.[Figure 7] At the end of the string hangs the shrunken image of the VIDEOPLACE participant. Finding himself suspended in this way, this participant wonders if there is any way he can make his image swing on the string. He tries a few exploratory moves. He discovers that by moving from side to side he can make his image swing, and then by timing his movements correctly, he can swing higher and higher. He wonders, can he do a 360? After considerable, frantic effort, he succeeds.

The interactions I just described are between the VIDEOPLACE and the VIDEODESK participants. However, there will often be a small crowd of people watching. They will cheer when the VIDEOPLACE participant succeeds in making his image swing all the way around. They will also laugh when his image is knocked down. How often have you ever seen a computer used to make people laugh?

Goggles & Gloves

What relationship does the VIDEOPLACE medium have to the goggle-and-glove technology that is often considered the orthodox way of creating artificial realities? First, the instrumented glove is a way for the computer to see what the participant's hand is doing. The instrumented suit is a way of perceiving the articulation of the whole body. Video cameras are a far less obtrusive way of accomplishing the same results. While the VIDEOPLACE system currently only understands the movements of the participant's two-dimensional silhouette, using additional cameras to understand the participant's movements in three dimensions is a straightforward, if difficult, problem. As long as the glove or the suit do not provide tactile feedback, there is no great advantage to them.

Similarly, the purpose of goggles is to completely immerse the participant in a computer-generated world. Admittedly, one video projector does not do that. However, it would be quite easy to use several projectors to surround the participant. Alternatively, light-weight glasses, recently designed for viewing 3D movies, could be worn. These glasses block one eye and then the other as the appropriate stereoptic view of the scene is projected. These glasses are far less encumbering than current goggles and permit high-resolution graphics to be used.

Typically, the dominant mode of interacting is through the glove alone. One points to indicate the direction one wants his point of view to fly. Of additional concern are the wires that tether the participant to the computer. You are concerned about tripping on the tether as you walk about. Since you cannot see it, you know that you are in the dark about the real world even as look around the graphic one.

In the long run, the reality goggles will become less encumbering. Eventually, they will be the same size as standard eyeglasses or even contact lenses. With such a convenient display, wearing instrumented clothing will be even less attractive. Our expectation is that when such goggles are available, it will be natural to use video cameras to perceive the participant's body. Thus, the VIDEOPLACE medium may be combined with the head-mounted display.

Currently, the VIDEOPLACE system responds far more rapidly than the goggle-and-glove systems, in spite of the fact that analyzing a person's image through a video camera in 1/30 second is a more difficult problem than monitoring bend sensors worn on the participant's joints. The reason is that VIDEOPLACE is a speciallized parallel-processing system dedicated to perceiving human images while the goggle systems use off-the-shelf computers running time-sharing operating systems.

The difference in performance is based on an important philosophical difference between the implementers of the different systems. An interactive experience is compelling because it responds in interesting ways to the participant's behavior. Its authority does not derive from the realism of the graphic world portrayed. Similarly, theater succeeds because of the dramatic human interactions depicted, not because of the stage craft. Indeed, there are types of theater in which sets are not employed. Of course, graphic realism will be of interest in the future. However, it is currently achieved by sacrificing the immediacy of the experience. Thus, when you are wearing goggles and turn your head, there is a very noticeable lag (sometimes as long as a second) before the graphic world catches up with you. When you move your hand, your graphic hand hangs in the air for a long moment before it moves. These lags are very disturbing. They instantly alert you to the fact that the experience is not real. They are also avoidable with current technology. Simple graphic worlds can be rendered more rapidly than complex ones. By way of contrast, the VIDEOPLACE participant is represented by his silhouette image, not his full-color video image. However, the participant never asks, "Is that me?" Instead, when they see CRITTER approach their silhouette's head, they duck. In the STEP LIGHTLY piece that I did for the SIGGRAPH Art Show in 1990, a laser mounted on the ceiling drew simple graphics on the floor that responded to participants' movements around the room. The most successful interaction showed a fish that swam after participants as they walked about. The graphic fish was very crude, but no one complained that it did not look like a fish. Its reaction to their movements was so immediate that its behaviour was realistic, even if its appearance was not. Visitors reacted instantaneously to the reality of the experience by running away and laughingthe experience was very funny. The primary concern should be the quality of the interactive experience, not how it looks in still pictures.

Content

In the late 1960s, it was common, particularly among intellectuals, to portray technology as threatening. One goal of my early exhibits was to provide the public, especially those beyond formal education, with a brief experience that communicated the possibility that computers could be benign.

Today, after 10 years of personal computers and video games, that message is no longer novel. However, there are points that are made by the exhibits that are still fresh. First, the world of the intellect, rendered sedentary by Guttenberg, now permits you to participate physically. Second, perceptual experience rather than abstract symbols will be used to communicate concepts. Third, computers are going to perceive younot because of malevolent government, but because we wish computers to be aware of us as other people are, as human beings with bodies and faces. Fourth, computers will be used to create artificial entitities like CRITTER that will interact with us. Whether these creatures are truly intelligent, does not matter. People will impute intelligence to anything that behaves. Fifth, simulation is a central scientific and technological strategy. Increasingly, we will make our mistakes in simulated worlds so that we may "do it right the first time" in the real one. Sixth, telecommunication will create a place in which we feel like we are together rather than communicating between two disjoint locations.

In addition to illustrating broad concepts, artificial realities can provide more direct educational experiences. In a 1976 proposal to the National Science Foundation, I proposed that VIDEOPLACE be used to create an artificial reality that would be explored by elementary school students who would be assigned the roles of scientists landing on an alien planet. They would enter this world individually and later compare their experiences. They would find that different children had observed different phenomena. They would note that different behaviours had elicited different consequences. They would discover that some children were able to describe what they had observed clearly, whereas others were uncertain themselves about what they had seen. They would disagree about the causal relations that were operating in the graphic world. They would seek a means of determining who was correct. They would conceive critical experiments. In short, they would invent the scientific methodthe process of science as opposed to the vocabulary and mathematical puzzle solving that are so often confused with science. It should also be noted that it is the students, not the teacher, who are doing the talking.

Certainly, the technology can also be used to deliver explicit content. Since we had very little time to test the software before the STEP LIGHTLY exhibit opened, we had decided to have the fish pursue the center of gravity of the participants if several were present. We were concerned that this would lead to an uninteresting interaction. To our surprise, we found that Ph.D. researchers, while fully aware of the mathematics involved, had no intuitive sense of what the concept meant and were delighted to have it made palpable. Since

VIDEOPLACE is a completely composable medium, a universe of such experiences could be directed at specific content.

Another instructional use was demonstrated in the Tomorrow's Realities Gallery at SIGGRAPH 91 in Las Vegas. Two VIDEODESKs were connected together. A gallery visitor sitting at one of the desks was instructed in the use of a gesture-operated application running on a SIlicon Graphics VGX340 workstation. The red hands of an expert user (in fact, a student volunteer with 15 minutes instruction) at the other desk demonstrated the use of the fingers to operate the applications. The student could ask questions, using his blue hands to point. Then, the instructor would show all ten fingers on the screen. This gesture would cause her hands to turn blue and the students hands to turn red, indicating that the student could now use his hands to operate the application. Now, the teacher could use her blue hands to point to the next menu item to be selected or to demonstrate the action that the student should be performing with his hands.

Two of the applications were of particular interest. These were novel in that the current two-dimensional VIDEOPLACE interface is used to operate in three dimensions. The first illustrated a problem in scientific vizualization, specifically depicting the flow of gases. The user's hands were projected onto a sample plane in a three-dimensional volume. Particles released from the fingertip followed the path dictated by the simulation. Two fingers were used to define a line and the air that flowed through the line defined a surface that was then distorted as if flowed around two skyscrapers. The sample plane could be oriented and positioned anywhere in the volume. In the second application, the same interface was used to create three-dimensional sculptures. Graphic material was extruded through the user's fingers as he changed the shape of the aperture.

The teletutoring exhibit demonstrated a means of sharing information that was invented in the METAPLAY exhibit in 1970. The teletutoring function was extremely successful. If VIDEODESKs were placed in school libraries, students could talk to Museum staff about text, graphic, or animated image information just as they would if they were sitting side by side. For often-asked questions, animated gesture-plus-voice answers could be triggered by the staff member who would then assist another student at another desk.

The Future

My new book, Artificial Reality II (Addison-Wesley, 1991) considers a variety of futures for my work. For instance, VIDEOPLACE technology could be extended to provide 3D perception of a participant's body and to permit movement of many people through 3D worlds. For years, its use for aesthetic, practical, and telecommunication purposes has been impeded by funding limitations, not technological difficulties. However, it is but one of a variety of interactive media, including head-mounted displays, laser floors, and interactive buildings, that will permit full-body participation in computer-generated experiences. The future will demand a variety of interactive forms rather than a single dominant one, for interactivity itself will be the universal medium.

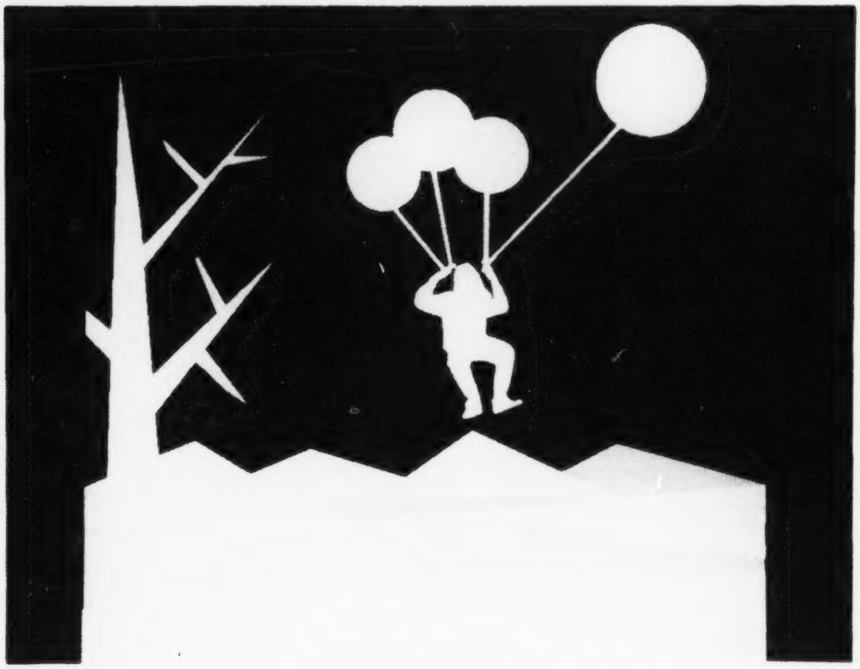

Figure 1. Parachute

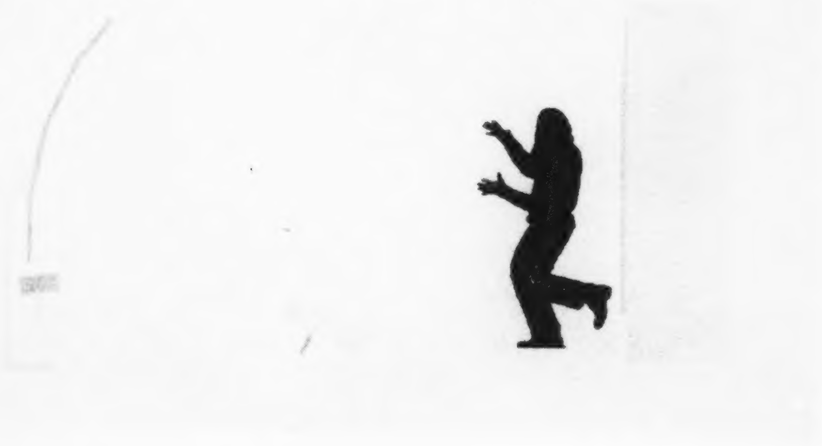

Figure 2. VIDEOPLACE installation

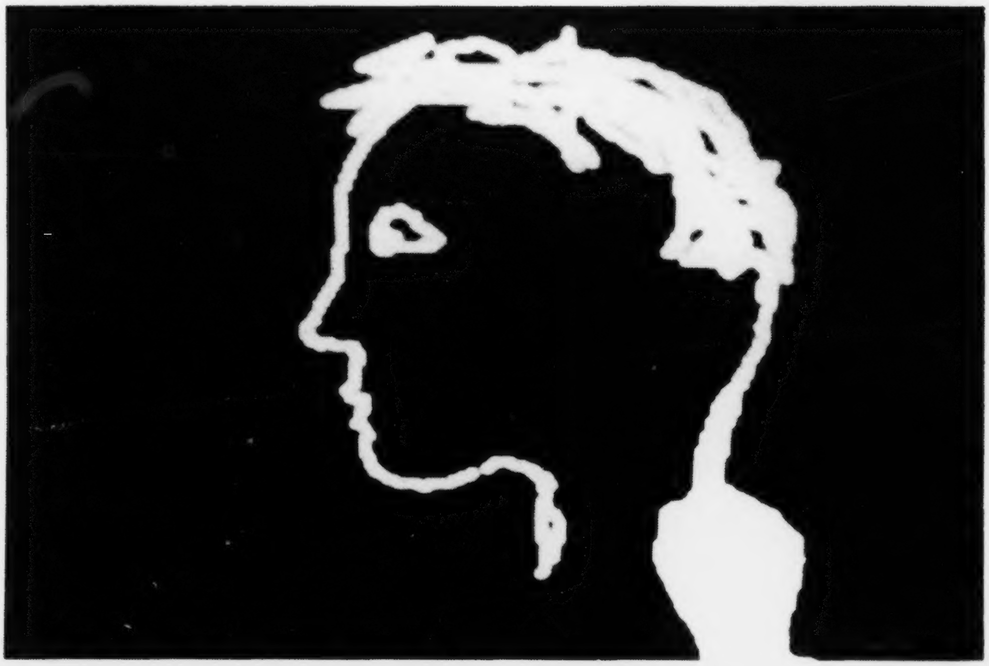

Figure 3. DIGITAL DRAWING

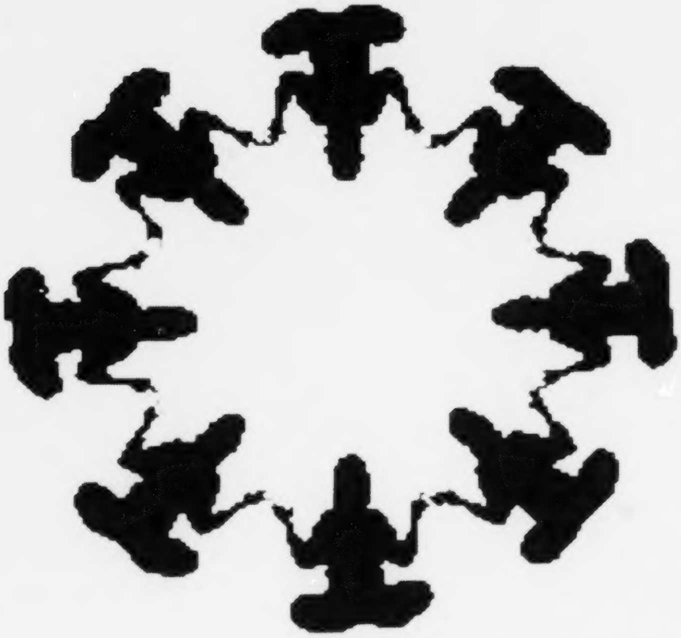

Figure 4. MANDALA

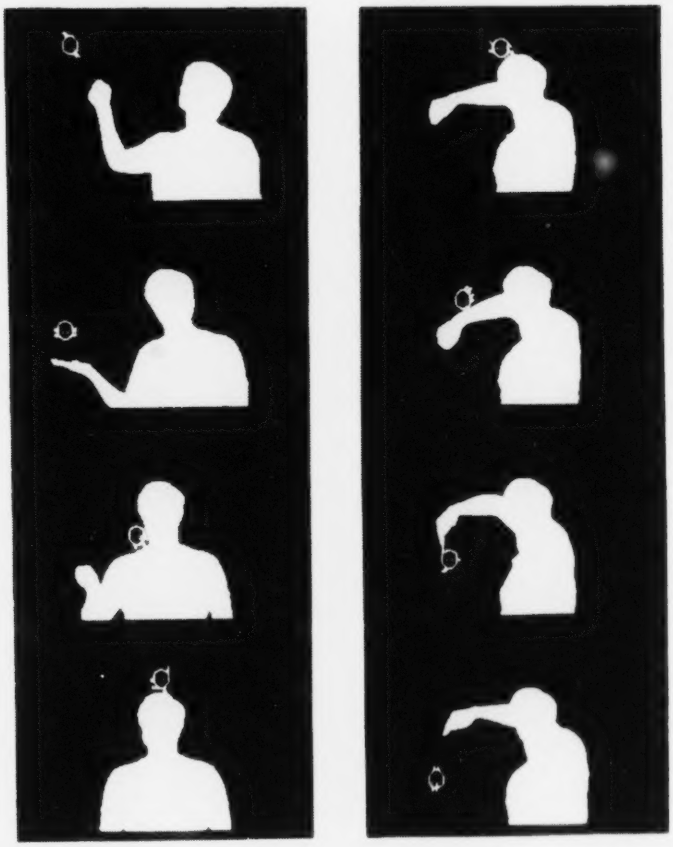

Figure 5. CRITTER

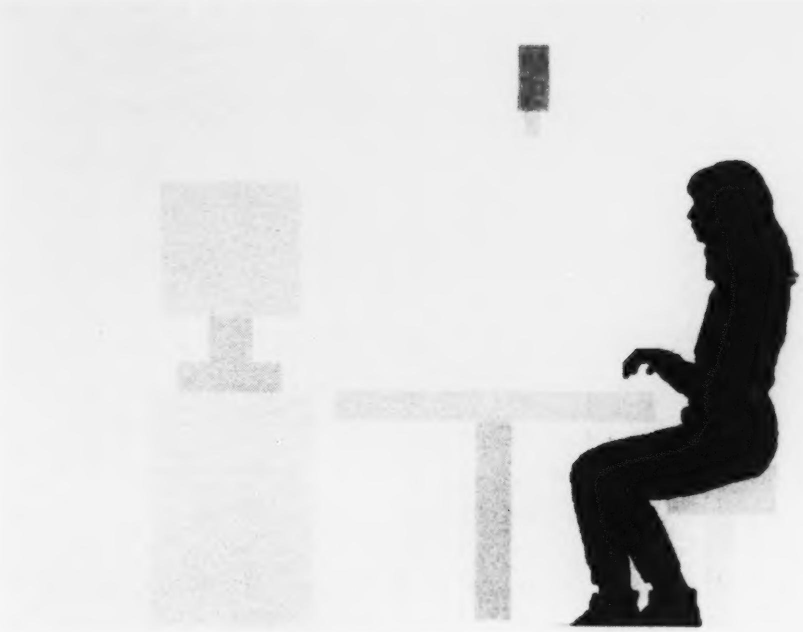

Figure 6. VIDEODESK installation

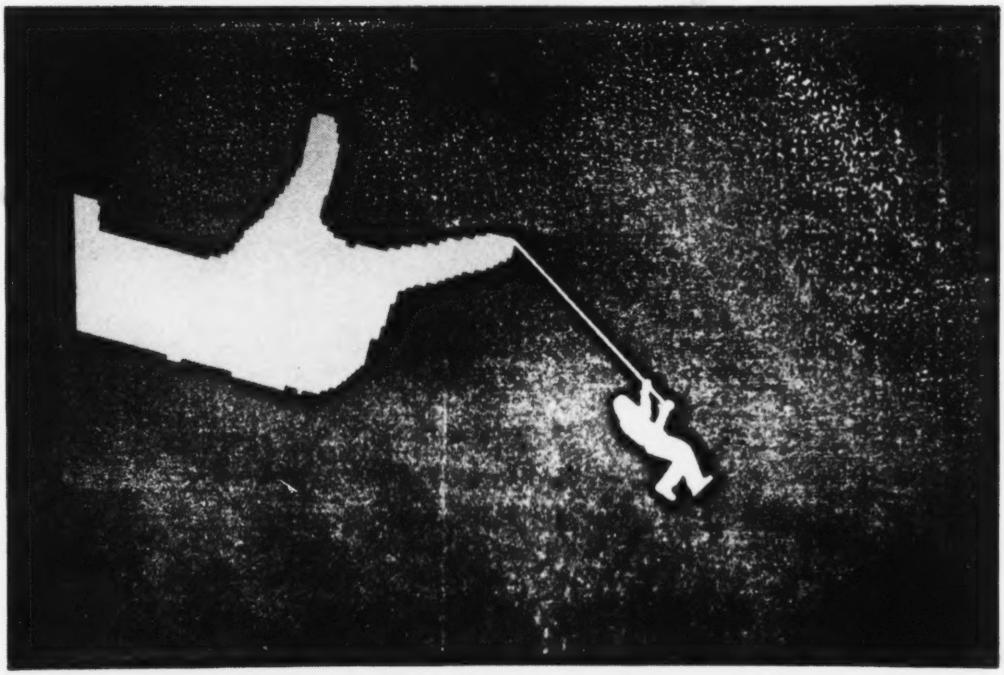

Figure 7. HANGING BY A THREAD

Intellectual Property and Multimedia

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Abstract

This paper adresses some of the intellectual property issues which arose during the planning and production of SIULLEQ, a Danish multimedia project about Greenland and its culture. They include copyright, moral rights ("droite morale") and the implications of the Danish Data Protection Act in relation to the creation, use and downloading of materials by different categories of end users.

As regards the non-commercial use of SIULLEQ by educational and cultural institutions, existing copyright subscription systems in related areas in Denmark can be adapted to encompass multimedia products. The author concludes with some observations regarding the future of multimedia in education.

1. Introduction

Electronic multimedia distributed on optical discs began to appear on the market ten years ago. Early titles included "Vincent van Gogh", "The National Gallery", and "Bio Sci", essentially visual resources on video discs with software or printed indices, sometimes including barcodes. Over the last five years, the range of products and optical discs delivery systems has expanded although multimedia in consumer and educational markets is still a niche industry.[1] As these products involve the capture, storage, representation and dissemination of text, sound and images in an integrated manner, they cannot easily be allocated to one particular copyright collective.

I choose the term "intellectual property" rather than "copyright" when discussing multimedia as there are several rights involved:

- copyright in the sense of "right of the author" (ophavsret, droit d'auteur, Urheberrecht), moral rights assigned to the author and his successors to prevent the distortion of his work and to assure that he is identified as the author of the work.
- copyright in the sense of "right to copy," pecuniary rights in the form of a limited monopoly given to the owner to stimulate and reward him for the creation of an original work. The period of this monopoly is usually related to the lifetime of the author. In Denmark, photographers enjoy a more limited right of 25 years from the moment the photo was taken.

A widely-held premise regarding the purpose of intellectual property rights is "both to stimulate the creation and public dissemination of works [in our case multimedia] and to give their authors a generous reward for their contributions to society."[2]

Educational users of multimedia want to be able to work interactively with a given subject, to search, select and (re)organise text, sound and images. The product must offer acceptable and reliable access at a price they can afford.

Producers and publishers of multimedia have to reconcile these potentially conflicting interests. Given the considerable storage capacity of many of the optical discs currently in use as distribution media, I should like first to explore the question of the economics of multimedia before going on to deal with our experience intellectual property.

2. The Economics of Multimedia for Education

Multimedia products vary considerably in price. The cheapest resource discs aimed at the consumer market retail for less than US$100, whereas more specialized products for vertical markets may well retail for twenty to fifty times as much.

There is no clear relationship between the price and "intrinsic value" of multimedia products for education. The latest edition of Danmarks Radio's catalogue of interactive media contains more than 90 titles ranging in price from 15 to 2,000 dollars. The price of discs such as the BBC "Domesday Project" (originally sold for 150 dollars each) and the Danish National Museum disc "Danish Resistance and the German Occupation of Denmark 1940-45" (retail price 220 dollars) reflect the conditions under which the products were produced. In the case of Domesday, there was significant funding from the hardware manufacturers and the European Commission. The Danish disc was developed initially as part of a public information system.

Where multimedia products have been developed on a strictly commercial basis, two of the critical factors influencing their price are projected *sales* and *production costs*. Sales of educational multimedia such as the ABC News videodiscs may exceed 10,000 copies whereas one is lucky to sell 50 Danish discs in the home market. Multimedia products from Denmark either have a high sales price or have to be bilingual or multilingual with a view to sales outside the country.

Where such products use specially commissioned content, the rights issues are dealt with in the employment contract. But multimedia products usually contain a significant proportion of repurposed content. The project "500 Anos Despues" (Five Hundred Years After) plans to offer a series of CD-I discs, of which 80% of the total content already exists. The cost of clearing intellectual property rights, especially large numbers of stills, is one of the most significant and time-consuming aspects of production. A product containing 10,000 stills will usually cost considerably more than a comparable disc with, say, 1,500 if the images in question are still in copyright and have to be paid for. As Nathan Benn recently pointed out in an article on editorial photography in multimedia, "Considering the large volume of photographs that multimedia can use, it is not surprising that the first wave of educational software produced relies heavily on public domain images from the 19th and early 20th century".[3] Benn's articles illustrate clearly that all is not well when it comes to the use of photographs in such products.

Multimedia for consumer and educational markets are price-sensitive, regardless of the nature and intrinsic value of the material. Japanese products for the Sony Data Discman - a hand-held CD-ROM player with screen and processor - retail for US$18-130. In the USA, consumer products (a disc and software or a CD-ROM) retail for US$90-200 and educational products for K-12 schools for US$400-800. In the UK, schools expect to pay considerably less (US$200-400) and the situation is very similar in Denmark and Norway.

In Danish schools, products costing less than US$150 can be bought on the recommendation of an individual teacher. Above this threshold, several teachers of the same subject have to support the proposal. If the price exceeds US$300 the product becomes extremely difficult to sell.

Anecdotal evidence suggests that it is the distribution *medium* rather than the *content* that determines the purchaser's price expectations. The price of multi-media product containing video and 11,000 stills is invariably compared with that of consumer media such as a video cassette, rather than the 11,000 slides it contains.

If multimedia are to find their way into main-stream educational and consumer markets, how are we to reconcile these expectations of end-users with the financial interests of the intellectual rights holders and the publishers? The strategy needs to be mutually beneficial, as no-one stands to gain if prices are set too high or low.

3. SIULLEQ

SIULLEQ (Greenlandic for "the first") is an interactive multi-media database, the aim of which is to describe Greenland, the country, its people, culture and environment. The major partners of SIULLEQ were DRIVE, the interactive media unit of Danmarks Radio, the Danish Broadcasting Corporation, and UNIC, the Danish Computer Centre for Research and Education.

The project was carried out in association with the Autonomous Government of Greenland. Contributors to the content of SIULLEQ include more than 400 individuals and institutions in Denmark, Greenland, Canada and the USA.

Danmarks Radio and UNIC have provided more than two-thirds of the US$ 1.8 million budget. The balance has been provided by the Nordic Council of Ministers and a number of private foundations.

Work on the project started in March 1988, and the final Danish-Greenlandic version was launched in May, 1991. It it is now commercially available to schools, libraries and museums.[4]

4. SIULLEQ - the original specification

At the beginning of the project we wanted to offer at least 30,000 stills and 30 minutes of video, as well as a minimum of 2 hours of audio. Users in Denmark and Greenland were to be able to choose different ways of accessing the content: via maps, a four-level hierarchical set-up, a visual mosaic and a conventional database with Boolean search facilities. The range of options was to include audio-visual introductions or essays, picture series, picture and sound series, and texts with related bibliographies.

A key requirement was that novice users could use SIULLEQ with a minimum of instruction, but that the system should contain authoring tools to allow "communicators" in schools, libraries and museums to adapt the system to their own needs. SIULLEQ was also to contain tools to allow teachers to produce simple work sheets containing small digital miniatures, maps, texts and bar codes so that the video disc could be used on its own *without* a computer but with a bar code reader.

SIULLEQ consists of the following:

LaserDisc videodisc:

- side 1: 10 minutes of video with sound, 40,000 stills, and approximately 25 minutes of music, predominantly in stereo.
- side 2: 35 minutes of historical film and video clips with captions, with a mono sound track where it exists. The second sound channel contains 35 minutes of historical sound recordings (music).

CD-ROM:

- database with texts,
- 10,800 digital miniatures of stills, and digital maps,
- 3 hours of digital sound of which 2 hours are speech in Danish and Greenlandic,
- a Greenlandic/Danish dictionary with 16,000 entries and additional reference materials.

5. Acquiring content

For large data bases such as SIULLEQ the cost of acquiring the rights to use and distribute information such as stills, video and text can be the major outlay, and thought has to be given to how large the database should be without making the cost of the final product prohibitive.

The producers and publishers of SIULLEQ constitute a collective legal entity. Following discussions with copyright specialists including COPYDAN, one of the performing rights societies, it became clear that there was no such thing as "one-stop" copyright collection which could have eased our administrative load.

We felt that the existing tariff structure was not directly applicable to our project. Because it would be impossible to recover all the production costs from revenue generated from sales of a Danish/Greenlandic version we approached potential contributors in early 1988 to discuss the rights issue. Individual contracts have been drafted for each contributor, covering the content to be included in SIULLEQ, the uses to which it may be put and language areas contemplated. These contracts contain an option to produce an English language version and to remunerate the author in the event that this version is released.

In most cases, authors and research workers have been willing to authorize the use of their materials free of charge, provided that they were reimbursed for the time they spent in finding and organising the materials required.

The reactions of both professional and amateur photographers were mixed. Some specialising in a specific field in Greenland saw SIULLEQ as an electronic catalogue of their work. Others were not convinced of the provisions made to reduce unauthorized copying, or could not accept the modest remuneration offered.

The legal situation governing music and recordings from archives turned out to be far more complicated. In the case of music, we have approached all those involved directly and are offering a sum corresponding to the revenue generated from the sale of a similar number of works on a compact disc. As regards excerpts from archival material, we have excluded all recordings containing music to simplify the copyright clearance. As the material stems from Danmarks Radio archives, we have first to clear the moral rights with the producers, artists and interviewees and then deal with the economic aspects as we have done for music. Where films were commissioned by Danmarks Radio but produced by independent companies, getting the necessary authorizations is extremely time-consuming.

Historical film and video recordings stem largely from the archives of the Danish Broadcasting Corporation. Here again, a recent test case brought by the Danish Journalists Association and the Corporation reveals how tricky the isssues are. In its findings, the court ruled:

- That the reuse of broadcast material in other broadcasts was a legitimate activity and the Corporation had the right to do as long as the moral rights stipulations of employees were observed
- The Corporation has the right to reuse broadcast material for other purposes on a commercial basis where the current Broadcasting Act clearly made provisions for such uses.
- The Corporation could not automatically re-use archive material in this way in cases where provision for these activities had not been made in the employees' contracts or in the Broadcasting Act in force at that time.

6.1 Storing content

Although we have not run into difficulties in this area, we have to take into consideration the provisions of the Danish Data Protection Act. This Act regulates governmental, county and municipal storage and use of information *in a digital form* about the race, creed and political and social activities of citizens. Even though this information may be public knowledge and have been published in printed form, it may not be transferred from one agency to another without prior authorization by the supervisory board. Developments this year allowing for local goverment agencies to cross-tabulate different registers coupled with discussions at European Community level should lead to changes in this area.

6.2 Representing content

The main issues here have been moral rights. As regards photos, we have endeavoured to consult the photographers concerned on the representation of their works on a television screen. In most cases, the images are displayed in their entirety and with a neutral gray frame with a white border. In some cases, the images have been electronically cropped to ensure that significant details can be seen.

For works of art and old cartographical maps, we aim to have both the whole work and close-ups. Stereoscopic photos will only be available as pairs of pictures, as the provision of stereoscopic images would have been too costly for the end users.

In the case of music, the sampling frequency (22 khz) and compression algorithms of the digital sound available are inadequate for music, and for this reason we have music on the videodisc only.

One of the other sensitive issues was that of archeological sites and the resolution at which they could be shown on maps. To reduce the risk of treasure hunters any such sites will be shown at a resolution which does not enable unauthorized investigations!

6.3 Accessing SIULLEQ

The materials will be made available subject to a number of conditions regarding their use. Following guidelines drawn up for Danish videograms, the material will be made available for private use and for non-commercial use in public educational institutions, libraries and museums. All other uses will require licensing. As state museums are likely to charge admission from 1991, we have asked our legal specialists to advise us on the consequences of this change. Will the use of SIULLEQ at the Danish National Museum as one of a number of exhibits constitute "a public performance at which admission is charged?"

We have also argued that while a given user of SIULLEQ has access to the whole content, the probability of a given picture, sound or text being accessed is far lower than in a printed work, given the greater size. This is the premise of our argument that rights payments should be more modest.

6.4 Downloading content

The full-scale system comprising an Apple Macintosh computer, LaserDisc player and CD-ROM drive contains tools for downloading simple maps, low-resolution digital miniatures, captions and bar codes so that teachers can prepare simple worksheets for use in class. The digital miniatures are to be used as iconic representations of the images which can be displayed by means of the bar code (cf. figure 2). The resolution of the images is such that they cannot be used for publications. The authoring tool ensures that copyright notices always accompany pictures and texts. They can only be removed from worksheets by mechanical means. As photocopying is governed by an agreement between educational authorities and the copyright collection society, copies of such worksheets made at schools represented in the annual sample would give rise to payments to the author or photographer concerned. Further details of this are included in an earlier paper on this subject.[5]

Nathan Benn's most recent paper[6] outlines a rights collection scheme for photographs used in multimedia originally proposed by Stanley M. Besen of the Rand Corporation.

The content of video discs can be transferred with some loss of quality to a video or audio cassette. In educational institutions in Denmark, there is an unspoken consensus that downloading to video or audio cassettes at schools for use in the class or at parent meetings is acceptable, but that other uses are not. It has been our practice to cover these issues in user guides and at presentations and courses on the use of multimedia. We feel that institutional abuse will be minimal.

7. The future of educational multimedia - is there one?

Multimedia products published in Europe for use in education have not had the impact that many of us had hoped. Projects such as Domesday, "500 Anos Despues" and Siulleq could not have been produced on a commercial basis given the size of the installed base of players in educational institutions. Multimedia databases in particular have tended to be large, often containing in excess of 20,000 stills. The limited impact seems to have three causes:

- the relatively high price of the user hardware compared with school budgets

- the cost of the materials themselves
- the need for extensive teacher training and/or preparation time before teachers feel secure enough to use multimedia.

The first cause can only be tackled by using simple systems such as a player and remote control or bar-code reader or awaiting the appearance of low cost systems such as CD-I or CDTV designed for consumer markets.

The second cause has no simple remedy in Europe, unless multilingual, multi-cultural materials can be prepared addressing the needs of different national curricula and educational traditions. This should increase the numbers sold, allowing prices to be kept down. "The Sahara Disc" project, headed by a group at the University of Cambridge, is currently exploring this strategy with partners in Denmark and Norway. Attempts should also be made to improve cost awareness at the education authority and school level. We feel that public money should only be spend on "pump priming," after which productions should be possible on a commercial basis.

The third cause reflects the demands made of the end user and the kinds of interaction being offered. Producers have assumed that both consumers and educational users expected highly interactive systems. Our observations of teachers in primary and secondary schools have lead to more modest kinds of interaction - including bar codes in worksheets - which can be handled by a majority of our potential users. With time they will gain experience and move on to more sophisticated materials.

Following discussions with other European producers, we hope to stabilise costs and therefore prices in two ways: by collaboration with cultural institutions and by reducing the content of the product to a more manageable size.

One way to do this is to follow up the work done with the National Museum on resource discs originally produced for their purposes. Museums and, to some extent, libraries and archives often have suitable material which could be made available on a commercially viable basis.

The concept of "multiple media" used in the Canadian project Jean Talon seems a sensible one: in the short term, products can be distributed on a range of media including video cassettes, floppy discs, videodiscs and compact disc formats leading on to interactive broadband systems within this decade. For those interested in the intellectual rights implications of networks, papers by Mark Stephens[7] and Francois Braize[8] are pertinent.

The second factor is to reduce the number of stills to a level where the medium still provides comprehensive coverage but where the cost of the content can be recovered from the sale of the product. We are currently working with the University of Copenhagen - and with the active support of the Royal Library and the Danish Cartography and Land Registration Board - on a multimedia product about medieval church murals. There are 500 Danish churches with a total of just over 4,000 murals still in existence. By making these and a computerised index available on optical discs, we can further education and research in Denmark and promote a small but significant part of our cultural heritage elsewhere.

Another proposal governing intellectual property and multimedia proposed by the telecommunications industry is to make initial, one-off payments after which materials can be freely distributed, ultimately in broadband networks. The problem with this approach is that it would prevent new authors or artists from gaining a foothold and lead to a reduction in the diversity of cultural expression. After all, who is willing to pay for something that may never be used?

Clearly, all of us have some interests in common to ensure that a reasonable balance between the creation and use of intellectual property is found.

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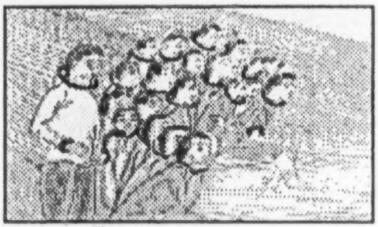
Examples of Greenlandic drum dances
SIULLEQ side A

© H.P. Møller Andersen 1991

Extract from contemporary Greenlandic drum dance on stage (KNR - Greenland Television)

First frame

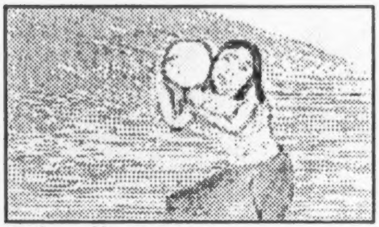
Play video 13130-13438:A



© Jens Kreutzmann

The first visual records of drum dances are to be found in works of art. In this watercolour, Ajagutak attempts to defend himself by means of a drum song.

Frame 24063:A



© Jens Kreutzmann

Both water colours are by Jens Kreutzmann.

Frame 24064:A

© Gert Hansen

Elderly Greenlanders in Julianehåb.
Woman in drum dance.

Frame 37311:A

© Frederik Carl Peter Rüttel 1900

One of the earliest photographs of a drum dance from Ammassalik in 1900.

Frame 17641:A

Exploring Mechanisms to Overcome Economic Disincentives to Rights Holders

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Explaining why he had founded Life magazine in 1936, Henry Luce said, "To see life; to see the world; to eyewitness great events; to watch the faces of the poor and the gestures of the proud; to see strange things - machines, armies, multitudes, shadows in the jungle and on the moon; to see things thousands of miles away, things hidden behind walls, things dangerous to come to; to see and to take pleasure in seeing; to see and be amazed; to see and be instructed; is now the will and new expectancy of half mankind."

Luce's call for images to be the primary medium for the communication of history and culture was revolutionary in his contemporary American publishing environment, where text was primary and illustrations played a secondary role. Fourteen centuries earlier, Pope Gregory promoted the use of images in the church because, he said, "painting can do for the illiterate what writing does for those who can read." Seventeenth Century Dutch artists were so powerfully descriptive that, by studying paintings, prints and drawings as primary data, contemporary scholars have substantially altered our interpretation of Holland's Golden Age. Throughout history, images have been used to persuade and to inform.

For more than fifty years, editors in mass-market print media have used photographs to inform, entertain and market. Today, the ability to create image-based, interactive media is a revolution comparable to the introduction of photographic reproduction to print media. But even though the power of images as information and entertainment is universally accepted, the visual content of current multimedia software is often dismal.

I suspect three reasons for the disappointing content of most current multimedia. First, the level of visual sophistication of our better print media may not yet be expected from software producers. Second, these producers often avoid copyrighted pictures because of the hassle in locating and negotiating with the many individual rights holders. Finally, rights holders have economic and other disincentives to discourage them from licensing their intellectual property. All of these problems need to be solved before multimedia can achieve its potential to benefit rights holders, software publishers, and society.

This audience represents many of the world's great cultural and scientific museums and archives. I speak from another perspective, as an editorial photographer and individual rights holder. We are similar, and we are different. For your museum, photographs of the collection serve to disseminate ideas and knowledge, second in importance only to the objects themselves. For the editorial photographer, the image has primary importance as the only tangible expression of our ideas and creativity. For museums, the distribution of photographs and the granting of reproduction rights are services to extend the reach of the collections, and may be a source of revenue. For photographers, royalties earned by granting reproductions rights enable photographers to continue to create. In order to survive as a profession, editorial photographers must overcome the economic disincentives of multimedia licensing, as our markets con tinue to devolve away from print media, and towards electronic dissemination of information and entertainment.

Rights holders, whether photographers or museums, earn royalties based on the economic value of the reproduction, display or perform ance of their intellectual property. The issue which arises in electronic media is that the use of images is far more volatile than print. Images on software are not only reproduced in a fixed context, but they may be used in other contexts. They can be transmitted, they can be downloaded onto other software and, when the resolution is high enough, they can be copied into print media. If these additional uses of the intellectual property are not authorized, they constitute copyright infringements. Of course the problem of infringement has always existed, but the proliferation of culpable technology makes infringements easier to accomplish and more difficult to detect.

Two options exist for the rights holder. The first option is to sell the electronic rights to another party for a fixed, one-time payment. The new owner of the rights assumes the economic risk of commercializing the images, in anticipation of earning a profit. If the one-time payment to the original rights holder is large enough, this may be an attractive option. However, the ultimate economic return on intellectual property is inherently uncertain.

The second option is for the rights holder to continue to earn royalties proportionate to the actual use of the images. To achieve this, we must clearly define the products for which our images are being licensed, and then define the secondary products and services that can be derived from our images. That's the easier part. The more difficult task is to measure each derivative use, assign appropriate economic values, and collect and distribute the royalties. To accomplish this task, our initiative integrates the paradigms for editorial stock photography distribution with music licensing.

Editorial Photography

The creation and distribution of editorial photography and ownership of copyright are dissimilar for newspapers, magazines and books. Reacting to television's ascendancy as the primary mass-market medium of visual information, the acquisition of photography for magazines and books has radically changed in the last generation, and the relationship between photographers, photo agencies and publishers is often a rude surprise to software developers who approach major publishing companies hoping to find one-stop sources of content for multimedia.

Books

Books with many photographs generally fall into two categories:

- 1) The works of a single photographer on a theme; and
- 2) Collections of pictures by many photographers on a theme.

Single photographer, single theme books are often the photographer's fulfillment of a personal commitment as an artist or documentarian to explore a subject. The tradition of the photographer working alone for many years to create a visual encyclopedia - today we might say image database - is almost as old as photography itself.

Eugene Atget, 1857-1927, is an unlikely figure to refer to in a discussion of databases. A Parisian, he was an actor and stevedore into middle age. But the last thirty years of his life, working from a cramped Montparnasse apartment, he created an image database of French culture. Aware that he was witnessing the industrial age obliterate Paris' pre-Revolutionary commerce and architecture, he photographed it with encyclopedic thoroughness. Every morning before dawn Atget would lug his awkward wooden view camera, tripod, and a few glass plates down still-empty streets to record the first misty light of day.

The few visitors who were interested in his photographs of Paris' bridges and fountains, shops, courtyards, gates and gardens climbed the creaky five flights of stairs to his quarters, and for a few centimes acquired a print, annotated on the back. For example, "Hotel des Archeveques de Lyon, rue Saint-Andre-des Arts, 58" would show 17th century doors, carved with profiles of Roman nobles, griffins and laurel wreaths, with two fleshy putti holding the noble family's insignia in the cornice above, one door open to reveal a bright, immaculately swept courtyard inside, and a sign "Apartment a Louer," Apartment for Rent, discreetly hung on a hinge.

Contemporary documentary photography in Atget's tradition is published in picture books of Civil War battlefields, Japanese gardens, Rumanian gypsy culture or Africa's endangered species. Most of these "image database" books capitalize on an independent photographer's personal interests. Few of the titles are shot on assignment. The photographer typically shops around for a publisher after all or some of the pictures are produced, and the union consummated when there is agreement on all issues including control of the final content and the photographer's compensation.

Rarely does either party consider an outright sale of the photographs to the publisher, but they share the risk and the rewards by negotiating a smaller guarantee at the time of publication against royalties pegged on the number of copies sold. These royalties usu ally range from 5% to 10% of the cover price, so that a $40 book may net the photographer from $2-4 for each copy sold.

Licenses for books that contain the work of many photographers are usually not negotiated for royalties. Instead, the publisher pays a reproduction fee for each picture. If the publisher goes back to press for another edition not included in the original contract, the negotiations with the photographer must be reopened. The lowest prices, close to $100, are usually paid for textbooks, for small photographs. A trade book cover photo may cost several thousand dollars.

Magazines

The magazine industry, even in its anemic financial condition, is the economic engine that sustains high quality non-fiction photography. Before television took the lion's share of advertising dollars, Life, Look, National Geographic, and other mass-market picture magazines, each had many staff photographers. Until the 1960s, publishers could afford to assume all the economic risks associated with photojournalism, and they owned the copyright to the photographs produced by their staffs.

Photography of the highest quality requires talent, hard work and frequent exposure to hardship and danger. For the best photojournalists, photography is not a job, but a spiritual calling and even a mystical experience.

The great photographer W. Eugene Smith, 1919-1978, had a turbulent career at Life magazine, quitting and being rehired repeatedly. In the late 1940s and early 1950s he produced the photo essays that set the narrative and aesthetic standards for documentary photography. Shadows and Substance, the photographer's biography by Jim Hughes, reports that Smith, badly wounded by Japanese shrapnel while covering Marines in the South Pacific, spent a year in painful recovery before he could physically handle a camera again.

In May, 1946, he took the very first photograph since his injury. The well-known image, "A Walk To Paradise Garden," shows his two young children, from the rear, as they emerge from a shadowed forest into a clearing. Nine years later Smith wrote about the painful physical and emotional difficulty involved in forcing his partially mended body back into the service of photography.

> ...The children were scampering every which direction. They approached a clearing roughly arched by the trees, and I became acutely sensitive to the lines forming the scene and to the bright shower of light pouring into the opening and spilling down the path towards us. Pat saw something in the clearing, he grasped Juanita by the hand and they hurried forward. I dropped a little further behind the engrossed children, then stopped. Painfully I struggled - almost in panic - with the mechanical inequities of the camera...and as the children stepped in space to complete my foreseen composition, I pressed the camera release to retain the image of that instant - to hold secure on film the vision of this minute fraction of time floating within eternity. A printable reproduction of a mental realization.
>
> The reaction was immediate. I knew the photograph, though not perfect, and however unimportant in the world, had been held. Shock waves of feeling

> released through me, breaking damply out of my flesh. Mist hazed my eyes, I began to tremble, nearly sick; I turned away that my children who had continued on might not turn and discover I was crying - crying out from the agony of my relief...

Photographers, artists and authors are attached to the intellectual property that is the fruit of their creativity by emotional and economic bonds. Smith was a brilliant photojournalist who channeled his spirituality into service for Life magazine, and Life symbiotically supported Smith by providing substantial economic and administrative support, as well as the outlet to publish his images.

While photographers are still highly motivated, staff positions for photojournalists have all but disappeared. Life, Time, Newsweek and USN&WR combined have only twelve staff photographers; even National Geographic has only six general field staff photographers, contributing less than 20% of the magazine's photos. Typically, magazines assign non-staff photographers, or use stock photographs, licensed through stock photo agencies or syndicates. General news magazines assign only 35% to 50% of the photographs they publish.Venerable giants like Time/Warner neither produce, nor own, much of the visual information on their pages.

When a magazine commissions non-staff photography, the copyright resides with the photographer unless there is a written agreement transferring it to the publisher. The majority of published editorial photos are not assigned, but are licensed for one-time use from the photographer, usually through a stock photography agent. Typically most magazine photography is shot by non-staff photographers, either on speculation or for day-rates and expenses from one or more magazines in non-competitive markets. By not requiring exclusivity, the publisher reduces economic risk and has cost-effective access to far more photography.

Stock Photography Distribution

The business of stock photography distribution is almost as old as photography itself. Matthew Brady pioneered the stock business, selling his cardboard-mounted views of the Civil War for the stereoscope viewers found in late 19th century parlors. With the invention of halftone printing, photography was published in books, newspapers and magazines; and photographers responded to new market opportunities by participating in stock photo agencies to more efficiently market and administer licensing of their images.

Compensation in Conventional Markets

Editorial stock photography markets include magazines, trade books, textbooks and encyclopedia. Again, many variables affect negotiations. While some pictures earn thousands of dollars from international syndication, a more typical fee is $200 for an image published in a textbook. Royalties for publishing stock pictures are divided between the photographer and the agency, most often a 50/50 split. Therefore, on a $200 sale, the photographer and agency each net $100. For the photographer, the accumulated royalties must justify his efforts, expense and risk to create and distribute new photography. The agency earns most of its income from its share of the royalty, and some additional income from research fees and holding fees.

The cost of administration for stock agencies per transaction make lower-valued markets unattractive. One agency that does a large portion of its business with textbooks and encyclopedia is Stock_Boston Inc. Their expense per transaction invoiced, including invoices for research and holding fees, but not including royalties paid to the photographer, is $91.11. Stock_Boston's expense per image licensed, including royalties paid to the photographer, is $174.94.

Acquiring Stock Images for Multimedia

At a conference last year, the audience collectively moaned when a multimedia software producer described the problems he faced in acquisition. He stated that the lowest price he was able to negotiate for bulk use of images was $35 each from The Bettmann Archive, for photos with expired copyrights and, therefore, no royalties payments to photographers. Considering the volumes of content that multimedia can consume, it is not surprising that the first wave of educational software relies heavily on public domain images from the 19th and early 20th centuries, available cheaply from the Library of Congress or Smithsonian Institution.

As public domain sources are depleted of fresh images, incentives increase for producers to utilize copyrighted images. However, there has been no incentive for photographers or agencies to license images at rates appropriate for software. No conventional paradigm satisfies the multimedia producer's interest in economical access to large quantities of copyrighted images, nor the rights holder's interest in fair compensation, nor offers the incentive to create new images.

Economic Disincentives in Existing Software Contracts

Alarms have already gone off alerting photographers to be skeptical about offers from a number of vanguard companies seeking images for software. Photo District News reported on the first wave of photographers who were discouraged from participation with software publishers. "Publishers say the CDs help photographers tap soon-to-be lucrative electronic markets," wrote editor David Walker. "But photographers are wondering who's protecting their copyrights. At the same time, some are feeling bamboozled as sales projections and royalty payments have failed to pan out."

Walker described the Media Source CD-ROM series produced by Applied Optical Media. Each Media Source CD contains 1,500 images, and sells for about $400. "With Media Source, you don't have to worry about copyright," an executive is quoted by Walker. "You can abstract images, manipulate them and resell them electronically without paying an additional licensing fee."

Applied Optical is reported to be paying 20% royalties on each CD sold. According to Photo District News, Applied Optical's president promotes Media Source to prospective photographers as an image catalog that will spawn additional print sales, an enticement also used for NEC's Image Folio CD. However, photographers later realized that these discs are marketed as electronic clip art, and that they do not spawn any requests for print media rights, and they generate few or no royalties. Some photographers reported that they never got even a single request for an image, and no royalties at all. "Yet NEC has continued to advertise the CDs in computer magazines, numbers of units sold total in the thousands, and the company plans to produce more," reports PDN.

Another well-known software company, seeking digital image rights eagerly, has contributed to further skepticism among photographers. The company commissioned a number of picture researchers to solicit photographers and stock agencies to supply photographs for specific products, for example a CD-ROM encyclopedia. Distribution is projected as limited, perhaps 5,000 copies in three years. They offer the photographer around $100 for each image, which might seem generous for a product which is expected to sell only 5000 units.

Then the Licensing Agreement appears, in which the rights holder grants the company a worldwide, perpetual, and irrevocable license to reproduce and manufacture products containing the images for a fixed fee, regardless of the ultimate number of copies produced, including all updates, new versions and new compilations. This is a very broad interpretation of a product, especially in view of new formats being developed, such as CD-I and HDTV. The software company is granted license to market, distribute, sublicense, lease and rent the products containing the images, as well as to grant sublicenses to OEM's.

There are no restrictions in the Licensing Agreement to limit the digital resolution of the images, nor to define the company's promotion, distribution, and copyright protection of the product. Thus it may be argued that the company is licensed to distribute a version of the product with high-resolution images that can easily be downloaded for derivative use. Does the software producer have any interest or obligation to protect the photographer's copyright? Photographers are being offered $100 for extensive electronic rights, and could soon find themselves competing with the software giant for the distribution of their own intellectual property. The June, 1991 newsletter of the Picture Agency Council of America, stock photography's umbrella trade organization, called this contract a "digital-image bombshell."

Copyright is referred to as a "bundle of rights," including the right to copy, the right to distribute, the right to display or perform, and the right to create derivative works. Each of the rights may be licensed separately and assigned separate economic values. In considering "digital image rights," we must also unbundle the package and precisely define which of the various uses for digital images are being licensed.

For example, is the image being licensed as part of a single, self-contained multimedia disk, or is the image part of a picture collection that can be extracted to support many different products and services? Is the multimedia product being promoted and licensed for personal use, or is the product being licensed for commercial applications, or being networked or broadcast to many consumers? Will the product be marketed as a source of clip art? At what resolution are the images being reproduced? What responsibility does the publisher have to protect the rights holder's copyright?

Contractually defining the separate digital image rights and issues is not intended to restrict the publisher or the consumer. Electronically disseminated intellectual property encourages volatile media, with new opportunities for information and entertainment delivery. However, rights holders are entitled to royalties based on the economic value of the actual use of their content.

From the rights holder's perspective, there are persuasive reasons to boycott electronic media. The business principle of image licensing is control of reproduction rights, and compensation when those rights are granted. In print media, infringements of copyright were kept at a tolerable level. In the digital environment, with its array of personal computers, scanners, optical and magnetic storage, high speed printers and networks, the familiar technological fences to copyright infringement have disappeared.

Hand-in-hand with the development of culpable technologies, public attitudes towards intellectual property threaten all rights holders, whether authors, photographers, songwriters or publishers. Warned Suzanne Dupre, corporate counsel for the National Geographic Society, "This is a multi-faceted problem. Everyone is a part of an increasing problem in modern society of rampant violation of copyright. We now have two generations of people who have grown up in this country assuming that they can tape off the air; that they can make copies of a tape they buy for their friends; that the Xerox machine is readily available to make as many copies as they want. It's going to be very, very tough to turn this generation around from the idea that because it is available, because physically it can be reproduced, that they have a right to just take it without compensating."

Towards a New Paradigm for Multimedia Markets

In 1987, the National Geographic Society sought to acquire rights to publish a pilot videodisc and a CD-ROM. Non-staff National Geographic contract photographers, like myself and colleague Cary Wolinsky, were asked to license our images at very low rates. We began 144 to investigate the industry standards for licensing images for software and quickly discovered that there were none; indeed, there was no industry. Then we met Dr. Stanley Besen, a Rand Corporation economist, who had studied the effects of new technology on the markets for intellectual property. Stan suggested that photographers look towards the music industry as a possible licensing model. He recognized that the inability to technically prevent unauthorized copying, dissemination and application of images in electronic media is comparable to the dilemma faced by songwriters. Music rights holders are compensated by royalty-based transaction fees forrecording fixed products, whether a record, tape or disc. The purchaser of the fixed product buys a "thing," a recording for his or her private, non-commercial enjoyment. With very narrow exceptions, the purchase of a record does not transfer the right to electronically disseminate or download music, nor to create derivative works.

When music or images are used in commercial applications or electronically disseminated, this use takes on the attributes of a service. Continuing the music paradigm, images could be collectively licensed by subscription, offering the image user a blanket license based on the value of the image service to the application, and royalties based on a survey of use could be distributed to rights holders.

The rights holder voluntarily joins an organization that represents his interest in these markets. Dr. Besen explained, "These organizations -- known as performing rights societies or, more generally, copyright collectives -- are granted permission by their members to license their works. In joining a collective like ASCAP or BMI, (the rights holder) grants substantial discretion to the collective in determining how his work is to be licensed and for what fee. Indeed, the collective can be successful only if such discretion is granted. Although joining the collective is a voluntary act, the composer gives up a considerable degree of autonomy to the collective when he joins. Nonetheless, performing rights societies generate substantial incomes for their members."

The compelling factor in the rights holder's choice of whether to license his or her intellectual property through individual voluntary negotiation, or to forfeit control to a collective, is the bottom line. If an image is being licensed to Life Magazine, the value of the transaction justifies individual negotiation between the editor and the photographer or the photographer's agent. When thousands or millions of photographs are available for display on electronic networks, a uniform value must apply for each image. The compensation to each photographer is determined by the frequency with which his or her images are used, as determined by a use survey .

Reproduction Rights Organizations

The music industry is not alone in facing the problem of unauthorized and uncompensated commercial use of intellectual property. The Copyright Clearance Center (CCC) was founded in 1978, responding to a Congressional recommendation for an efficient mechanism to grant rights to photocopy and return appropriate revenues to the rights holders. American publishers were claiming that widespread copying of their works resulted in a significant loss of rights and income. In 1990 the CCC administered reproduction rights for 1.5 million publications, representing approximately 8,400 publishers.

Copyright collectives, like the CCC, to administer rights to printed material are referred to as Reproduction Rights Organizations (RRO). Twenty-one such RROs conveying reproduction authorizations are members of the International Federation of Reproduction Rights Organizations (IFRRO). RROs not only serve rights holders' interests but also serve publishers and distributors of intellectual property by offering a streamlined administration structure for efficient and legal access to content. RRO's ultimately serve the public interest by facilitating the creation and distribution of intellectual property.

Can Copyright Survive Electronic Media?

The CCC recognizes that the digital information environment requires new licensing paradigms that are appropriate to the technology of databases, networks and multimedia publishing. The CCC convened a colloquium to discuss the copyright and economic implications of electronic use of full-text materials. The participants agreed that rapidly advancing technologies constitute an unprecedented challenge to the copyright system. Their report concluded:

> "If computers are in fact becoming the printing presses of the future, will legislators recognize them for what they are? Can a copyright system, organized around the capabilities of paper publishing, successfully cope with the greatly expanded functionality of computers? Will legislators, and the society in general, conceive of computer use of information as somehow different from publishing, and attempt to regulate it in different ways? Users and rights holders alike need to avoid a government-imposed solution. Therefore, rights holders and users must define and generate workable solutions which maintain the copyright system, standardize developing technologies and streamline access, dissemination and royalty payments for the electronic use of copyrighted materials."

Clearinghouses for Content

The good news is that workable solutions are on the way, at least for still images, by combining digital image management and streamlined licensing to efficiently distribute pictures and collect royalties.

The Electric Book Company was founded in 1990 by this speaker and colleague Cary Wolinsky. EBC's business will incorporate all phases of still image distribution, including archiving, licensing and copyright enforcement. A gateway to images from a consortium of stock photo agencies, EBC will help photographers to access new media markets and lower the administrative costs associated with stock photography acquisition.

As a clearinghouse for rights holders, EBC's implementation will promote the development of new, image-intensive products and services for education, information and entertainment. The company will provide transaction and subscription options to streamline licensing, and will apply digital image management technology to streamline fulfillment. Copyright protection for EBC-represented images will be enhanced by the efficiency of larger scale to implement technical, market and legal disincentives to infringement.

Electric Book Company is working with Eastman Kodak to implement a Photo CD-based high-resolution digital image management system, and Eastman Kodak is active in the development of technical and legal safeguards, and is sponsoring educational projects, to protect the interests of photographers and other image rights holders.

Museums and archives may also benefit from the services of an image clearinghouse. EBC's strategy is to implement the first phase of the business with the stock photography industry, where we benefit from many years of personal experience. However, the multimedia integration of contemporary photography with paintings, drawings, maps and other images should be seamless to the publisher and consumer. We all face the same challenges in image distribution and licensing, and in copyright protection. We define ourselves as a utility that will be available to all still image rights holders, including museums and archives.

Towards a Mutually Beneficial Solution

Thomas Jefferson warned that the success of a democratic society depended upon an "informed and educated" populace. Today, databases, networks and multimedia can incorporate the information-rich content of the printed page with interactivity and the popularity of electronic media. Paradoxically, unless there is an appropriate licensing mechanism, the new information technologies can undermine the economic incentives for the creation and distribution of worthwhile new content.

Enforcement of copyright, clarity in defining the rights being granted, and distribution of appropriate royalties will serve the public interest by making independent rights holders eager and productive participants in the new media. Development of intellectual property clearinghouses can solve the bottleneck of image distribution and licensing.

Intellectual Property and Interactive Multimedia Collaborations

Jeremy Rees
European Visual Arts Centre

As soon as you start analysing the full extent of the intellectual property aspects of image databases and interactive multimedia, the immediate reaction to the complexities which face you is frustration and hopelessness !

The alternative is to start exploring pragmatic approaches to the many problems.

1 A context

I hold a strong personal view that the development of image databases in art museums and galleries should, from the outset be as much concerned with their use by general visiting publics and for more formal education use (by teachers and students at all levels) as with their use for museum management.

Few art museums, collections or temporary exhibitions in Europe (or elsewhere) provide opportunities for their visiting publics to directly or indirectly explore for themselves, aspects of the permanent collections (whether hung, on loan or in store) in any depth; temporary exhibitions and their contexts; the work of an individual artist in the context of other work and influences; the historical, social or other contexts that gave rise to the creation of and the subsequent national/international distribution and display of this art. Many art museums have extensive libraries but even where these are, in principle, available to the visiting public, few are organised and accessible in such a way as to make casual public use a reality.

The "quality of experience" of visits to and general use of art museums, and the limited role of exhibition catalogues are subjects that have been suprisingly little researched. Few people actually read an exhibition catalogue in any depth while they are in an exhibition or even afterwards. Eventually the catalogue finds a place on the bookshelf, often still unread.

There is clearly a need for additional context and background and for the exploration of ways in which visitors can be encouraged to spend longer and make more frequent (and more personally satisfying) visits to art museums and galleries. We have to find other, additional, ways of involving and enthusing people.

2 New attitudes to public information

Traditionally, solutions to these problems have been explored through the use of tape/slide sequences, linear videos and personal sound guides - all of which are relatively "passive" and somewhat limited in their potential.

What we need to be aiming to set up is the means and the encouragement to create a real dialogue bewteen the art museum visior and the art museum collection or individual works of art - between the viewer and the viewed.

Recent developments in information technology have led to the increasingly economic possibilities for image databases (combining text and image, utilising analogue videodiscs, or digistised images of a fast increasingly improved quality), sound and moving image sequences from film or videotape.

With conventional film and videotape, the material is edited and viewed sequentially (in a "linear mode"). With interactive media or multimedia, the material can be accessed in many different ways that are, to a greater or lesser extent, determined by the user - enabling a wide variety of personal explorations of the material, rather than only an "edited" view. This can lead to explorations that really do start to involve the user in the subject matter.

The feasibility study for the European Visual Arts Centre project at Ipswich (EVAC), in East Anglia in the UK, has proposed a new exhibition centre, in which equal importance would be given to exhibitions of contemporary and historical fine art AND to easily accessible information about art. Image databases and interactive multi-media will play an important role, alongside the more "conventional" information media of books, exhibition catalogues, periodicals, audio and videotapes.

This assumes that a greater dialogue and collaboration can be achieved between art museums and a published base of material. More crucially, a range of material that has common addressibility - which of course does not currently exist to any useful extent.

3 The real problem

While, for the instigator or developer of image databases and interactive multi media, one sort of headache is the rapid development of imaging and other technology with attendant fear of obsolescence, and another headache is the scarcity of staff time and financial resources another, the real problem (as many people are only just begining to realise) is intellectual property rights - which include copyright and moral rights.

"As our society grows more litigious, and as the amounts of money to be earned grow more fabulous, we will see a great deal of creativity applied to the interpretation of copyright law"[1]

The purpose of Copyright is "to protect makers of original works of art/craft/design against unauthorised economic exploitation, by enabling them to prevent and receive financial recompense for such abuses and, of course, to authorise exploitation for financial reward, if so desired"

Until the 1988 Copyright Act, copyright legislation in the UK had given little or no protection against abuses to makers reputations: public denial of their authorship and derogatory physical treatment of their works that were no longer in their possession, control or ownership. For many years the UK has been a signatory to the Berne Convention, which is the international agreement dealing with international "intellectutal property" matters such as copyright and moral rights. Each participating State undertakes to enact its own laws in terms that harmonise with those of the Convention, so that "intellectual property" abuses can be remedied by any maker "qualified" through being resident, domiciled or a citizen of any such Convention country.[2]

An interesting recent example of moral rights was highlighted in an article by the writer Gunter Grass in the UK daily newspaper, The Guardian.[3] Grass was objecting in the strongest possible terms to the use, by the Bundeswehr, of a reproduction of Picassos's painting Guernica in press advertisements for army recruiting.

4 The current situation

I am not an Intellectual Property Rights lawyer but will outline something of the current situation by giving a few examples.

At the moment, the copyright collecting societies have not, collectvely or even individually, formulated a policy regarding image databases and interactive multimedia. Clearances that have been negotiated, whether through copyright collecting societies or individual copyright holders or their agents have been on an ad hoc basis, negotiated project by project. In other instances, copyright has not been cleared or projects have gone to considerable lengths to avoid the use of copyright material.

Taking the current situation at face value, as Richard Francis outlines in his draft Report *Very Spaghetti*[4],"conventional copyright holders are prepared only by their experience with printed books and broadcast television. In the one case they can easily see the number of copies that will be produced and calculate a cost depending on the actual number of reproductions of the work. With film or TV a practice of copyright law has grown up where the rights are negotiated piecemeal for "the world or parts of the world, for cable and broadcast etc";it is unusual for rights to be sold outright to the programme maker or for the maker to purchase all rights unless he wishes to sell on freely afterwards. In a programme from the recent *Relative Values* series, not many more than 50 works would have been the subject of copyright negotiations for each programme. On an interactive laserdisc there may be as many as 50,000 images: not only would negotiation be prohibitive for all those images but the cost, at say 50 per shot would come to more than 2.5 million !"

5 Some irrationalities

In the US, adhesion to the Berne Convention took place on 31 March 1989. . It was thought unlikely that compensation for artists' work that had been reproduced or used without permission would be achieved retrospectively, even if the work continued to be sold after 31 March 1989, but it was thought that in future users would have to obtain the consent of the artist (or their estate) before using an artist's work. The same unsatisfactory situation existed in relation to the reproduction and use of work of European artists' in the US.

In reality, Attorneys have been at work and devised a methodology to ensure that unauthorised reproduction could continue to be made, on the basis that all works created before 1 March 1989 - in the US or elsewhere - (except the few that had been registered under US law) would remain unprotected. This situation has yet to be adjudicated in court.

I use this as an example of the irrationalty of the current situation - which, of course is further complicated by the fact that the situation varies in detail from country to country, even where they are signatories to the Berne Convention). There are many other countries who are not signatories and have other variants or no relevant legislation.

Clearly, dealing with this "Babel Tower" of legislation and "accepted practices" is going to be a major stumbling block in any form of international collaboration.

6 Some first steps

The Database Access Policy document of May 1991of the Canadian Heritage Information Network (CHIN)[5], sets out to formalise a policy to govern broader access to the national and reference databases of the inventory of the major museum holdings in Canada (to date, the Humanities National Database and the Natural Sciences National Database) and "to institute procedures to insure the quality of the resulting service".

This comprehensive document (for a text database) is useful but at the same time, to me at least, quite formidable. It is no doubt influenced by the Canadian Government commentary on its proposed "Amendment of the Copyright Act" (May 1987) which states (quite correctly) that "Companies are understandably reluctant to spend money and time to create a program when a competitorcan copy their original work in the 30 seconds it takes to duplicate a disc. Despite impressive growth the industry loses millions of dollars annually to unauthorised copying."

The European Commission in Brussels produced a Green paper on the problems of copyright in relation to information technology in 1988 and, more recently, in April 1991, a Forum on Museums Information Systems, organised in connection with the Narcisse Project (under the EC IMPACT programe) in Luxembourg included a European Working Party to consider the legal problems posed by the communication and dessemination of museum images.[6] It considered" the differences in national legislation, particularly as regards intellectual property rights for works of art, and reached the inevitable conclusion that this area had to be harmonised (duration of protection, system of exemptions, related rights etc).

It goes on to consider five types of legal problems:

- the necessary legal framwork
- the intellectual property rights
- the responsibilities
- the transborder data flow
- the problems related to the creation and operation of a telematics service

It finally concludes that "the only piece of advice that the working party could give to image bank producers was that they should protect themselves with all the requisite guarantees and:

- thoroughly understand the legal framework in which they were operating (legal systems and relevant regulations).
- respect the rights of others in order to have their own rights respected (the right to plagiarize would entail the right to be plagiarized).
- make use of existing legal procedures as a means of legal protection and obtain the necessary contractual agreements."

Again, under the auspices of a European Commission (ESPRIT) project, CITED (Copyright in Transmitted Electronic Documents) was announced in March 1991, with the objective of defining a model for technical protection of the intellectual property and/or copyright invested in digitized information services. It is aimed at the protection of information (data and images) that is produced and processed with the intend to desseminate it commercially.

7 A pragmatic approach

7.1 A European Visual Arts Information Network

Discussions about the application and development of image databases and interactive multimedia with people in many European (and other countries) led to proposals for a European Visual Arts Information Network (EVAIN).

The concept was to bring together art museums, cultural authorities and people in education - to exchange information, ideas - and to work on joint projects to increase the availablility, commonality and addressibility of image-based IT projects, for both museum management and public information.

The concepts and aims were discussed eighteen months ago, at a meeting of people from nine European countries, organised by EVAC in Amsterdam. One of the most important aspects of that meeting was the discussion of a paper that EVAC had prepared in consultation with the DACS (the Design and Artists Copyright Society) and copyright lawyers on the subject of intellectual property rights.[7] The proposals set out three "layers"of usage and are summarised in the accompanying table.

7.2 The ITEM database

The first practical step in the establishing of EVAIN has been the launching of the ITEM (Information Technology in European Museums and art galleries) database, to be continuously updated and published twice a year on subscription in both hardcopy and on diskette (for both PC and Apple Macintosh platforms). The first issue came out in February 1991,the second issue was published in July and the third is planned for January 1992.[8]

With modest financial assistance from the European Cultural Foundation, Amsterdam, the Gulbenkian Foundation, London and the EC (DGX, Cultural Action) in Brussels, ITEM has already been a considerable success with subscribers from all over Europe (Finland to Spain), North America, Australia and Japan. It is also developing working links and exchange of information on image databases with the Clearinghouse museums database at the Metropolitan Museum in New York.

8 A European/international pilot

No paper or talk about interactive multimedia would be complete withou a pilot project attcahed to it in some way !

Discussions are proceeding with the intention of EVAIN developing a pilot interactive multi-media project, centering on the work of a key twentieth century artist - possibly the Romanian sculptor Constantin Brancusi, who lived a significant part of his working life in Paris.

8.1 The main objectives of this EVAIN pilot would be:

to create an interactive multimedia public information system, rich in material, with a sympathetic human computer interface (HCI) that offered a variety of levels and paths of enquiry and exploration, recognising the very different levels of users pre-knowledge and depth of interest

to develop a European/international collaboration between one (or, preferably, several) existing image database projects and several art museums and cultural authorities in Western and East Europe/internationally, who have not yet developed any projects of their own

to develop and test interfaces between different museum systems, including on-line image and data transmission Such a project would demonstrate many of the aspects in which we and others are interested in developing, and would test many of the practical intellectual property rights problems.

8.2 The Proposed Partners are . . .

- EVAC and several art museums of differing sizes from two or three Western European countries, two of which would already have image database projects.
- an Eastern European Cultural Ministry and cultural institutions and several USA art museum and other partners
- Software and Hardware developers, including a detailed human computer interface developer
- one or several European Telecoms
- an IT publisher -
- liasion with CIDOC on a standard short entry (and, ideally, longer entry) data entry format. lastly but by no means least,
- a European Copyright Collecting Society; yes, as a development partner. In fact, agreement in principle on this has already been reached.

We hope that it will also be possible for the copyright partner to also achieve the active (or passive) involvement of other CIAGP members (copyright collecting societies concerned with visual copyright).

8.3 Scope

- multi-lingual
- hard copy printout facility
- on-line transmission of images and text
- per item copyright fee charging and logging for image printout - facilities for user authoring
- downloading of images and text to videotape
- facilities for recorded user feedback

In persuance of EVAIN's stated belief in the importance of building on what has already been successfully achieved, rather than yet again "re-inventing the wheel",the intention would be to take an existing image database development and build on that, creating new front-ends as necessary. An key element wouldbe a two part data entry for works of art - a "short-entry" for the public access aspects and a "long-entry" (that had restricted access) for museum and collection management purposes.

8.4 Intellectual Property Rights

By choosing an artist whose work is still in copyright, and a project which would bring in a number of other artists (living and dead) whose work is in copyright, the project would be a valuable test-bed for not only the greatest complexity of permutations of copyright, but the wider issues of intellectual property rights. With a Copyright Collecting Society as a development partner, it will be possible to explore these challenges more quickly and, hopefully, more successfully, than by any other means.

9 In conclusion

To quote Charles Clark in his article "Electronic Publishing and the Law - An Agenda of Question Marks"[9]

> "This contribution ends where it began, in a plea that we recognize that computer-based works are a new form of work, and that owners and users stop picking out whatever features of traditional law happen to suit their particular interests. Instead, we must argue through the new and particular author, publisher and user features of computer-based works so that creativity, investment and use are all equally encouraged.....Let us Start new, and let us start now!"

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Color and Range Sensing for Hypermedia and Interactivity in Museums

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Abstract

A description is given of a laser scanning system for the acquisition of the three- dimensional surface data from objects as well as their color properties. The digitized data can be stored in compact data files that can serve for the reconstruction of any view of the object or scene on currently available graphic workstations. Three-dimensional hard reproductions are also possible from the same data. Examples are given of applications in the museum world. Key words: Computer color vision, computer imaging, range measurements, scientific examination.

Introduction

During the past few years, conservation scientists at the Canadian Conservation Institute have been working with engineers of the National Research Council Canada (NRCC) for the development of a system that would capture the 3-D shape and color appearance of museum artifacts. A prototype of the system now exists and has already been used for specific tasks in art conservation. The results obtained so far prove that the system can serve as a powerful input device in multimedia and telematic technologies (Figure 1), allowing not only the passive 2-D color representation of artifacts, but also complete 3-D color reconstruction, with full depth realism and ease for the user to select any point of view and illumination conditions.

This paper describes the system currently being developed and some of the results obtained so far.

Background: 2-D and 3-D Imaging

A 2-D camera essentially captures brightness measurements for each visible point in a scene. In early systems that made use of film, the mapping of points in the scene with points of the picture was continuous and so involved an infinity of points. With the advent of computer image processing, images had to be decomposed into a mosaic of small rectangular patches called "pixels" (picture elements). A 2-D digitized image is thus a mapping of brightness values to pixels. In black-and-white imaging, one grey value is assigned to each pixel while in color imaging, values of brightness in the blue, red and green are assigned to each pixel.

2-D imaging is so widely used mainly because a 2-D image is easily interpreted by humans through visual examination. One weakness of a 2-D image however is that it does not accurately define the object it represents and provides no precise dimensional or colorimetric information. For example, objects of different 3-D shapes can lead to the same image by choosing a proper perspective. Also, the same object can produce different brightness values when the lighting conditions are changed. Finally, a 2-D image provides only a static view of the scene, as it stood during acquisition; if N points of view of a scene are needed, then N images must be taken.

A 3-D camera provides a means to acquire the (x,y,z) coordinates of the surface of an object or scene. If an xyz reference frame is defined with the z axis pointing toward the camera, then one can think of a 3-D image, also called "range image", as a mapping of z values to surface elements ("surfels") of lateral coordinates (x,y).

The advantage of the 3-D approach is that the data provided is directly connected to the object and bears some form of device independence. For example, the diameter of a vase can be determine from its range image, irrespective of the attitude and distance of this object with respect to the recording device. For this reason, 3-D systems are finding more and more applications in the area of industrial inspection, robot vision and computer aided manufacturing.

Many tools have been designed for the visualisation of 3-D data by humans. Low cost software for "wire mesh" representation is available on most low end computers. At the other extreme, graphics work stations are specially designed to synthesize at high speed stereo pairs of any view of a scene, to be observed simultaneously for full depth and color realism.

Many 3-D cameras are currently available (see Besl for a survey). The performance of a system can be measured in terms of the accuracy of the data, sampling density achieved, and time for acquisition. The one presented here rates quite high according to these criteria and also offers the possibility of simultaneous color measurements.

Range Measurements

Basically, the NRCC laser sensor works by projecting a laser beam on the object and by measuring the angle of the reflected light, as detected by a solid state device located near the laser source. The know angle of the returning light and the known projection direction serve to calculate the (x,z) position of reference laser spot on the object, with an accuracy as good as 10 micrometers. A mirror scanning arrangement (Figure 2) sweeps the laser spot in the transverse x direction while its position is being sampled at very high rate. Two acquisition modes are possible: cartesian and cylindrical. In cartesian mode, the camera is mounted on a translation stage that moves continuously in the y direction, thus allowing to raster scan the scene. In cylindrical mode, the camera is stationary, but the object lies on a rotation stage that rotates 360 degrees during measurement, allowing panoramic acquisition of objects (Figure 3). Whatever mode is selected, the time to acquire a 512 by 512 high definition range image is less than one minute.

Color Reflectance Measurements

The color appearance of an object depends on its spectral reflectance properties as well as on the spectral content of the source that provides illumination. For documentation, analysis and multimedia applications, it is important that the spectral reflectance alone be isolated since it is an intrinsic object property.

In the system described here, the laser beam that serves for range measurements originates from a HeCd laser designed to emit simultaneously at three wavelengths in the red, green and blue parts of the spectrum. The solid state position sensor, inside the camera, also measures simultaneously the amount of light returned at each of the three wavelengths. Spectral reflectance values can be assigned to surface elements by comparing the brightness signals from these surfel to that from a white standard kept near the border of the field of view during acquisition. The calculation involves a compensation for the orientation effect: surface elements have the tendency to appear darker as the angle between the laser beam and the normal to the surface increases. This phenomena called "shading" follows a known mathematical law and can be compensated using the range data provided by the very same sensor.

Image Format

The laser sensor captures a collection of (x,y,z) and (R,G,B) values associated to surface elements This information can be kept in 4 compact computer files. The first file contains an ordered list of the depth values (z). The other three files contain the corresponding R, G, and B values. Because these data refer to the surface as sampled on a rectangular grid with equal spacing in the x and y directions, the (x,y) coordinates of a given surfel are easily recovered from the address of the data in the file.

With the current system, each z value is digitized into 12 bits and each R, G or B value is digitized into 8 bits. For a typical 512 by 512 image, 394 kilobytes are needed for the z file, and 263 kilobytes are required for each of the three color channels. The z file thus occupies only 33% of the total data storage. This is very little price to pay considering that the z file allows the calculation of any view of the scene from any point of view and for any lighting condition. Such small volumes of data can be easily transferred through existing computer communication links. Cataloguing of huge collections of objects is also possible since after data compression, about 2000 different objects can be recorded on a standard CD-ROM.

Data Display

With the present system, visualisation of the data is done mostly on a IRIS graphics work station, from Silicon Graphics Inc., equipped with a stereo display option that allows depth rendering to users wearing 3-D viewing glasses.

Software has been designed to ease data visualisation, and the user is given a menu of options. These can be grouped into three main categories:

- 1. Geometric display. With this option, only geometric information is displayed. Scenes can be synthesized from the z file alone into point, wire frame, and shaded forms.
- 2. Intensity mapping. This option is similar to the first one except that the sensed raw color brightness values are mapped on the corresponding screen pixels.
- 3. Color shading. Here, the brightness of each screen pixel is calculated using the recorded color reflectance data and taking into account the angles chosen by the user for the observation and source directions.

For each category, the user can perform rotations (Figure 4) and translations of the object represented as well as zooms. All of these are controlled through a "dial-and-button" box, and the computer reacts in real time.

A recent investigation of two paintings by canadian artist Tom Thomson provides a good example of the powerfulness of the 3-D approach. In this particular case, the task was to compare estate stamp impressions on each paintings with the metal stamp itself. Three-dimensional data were recorded by the laser sensor from the metal stamp and impressions. The synthesized images of the stamp and impressions were carefully oriented and displayed together on the computer monitor, and the superimposed data could be examined for determination of any discrepancies.

Image Reproduction

Any synthesized view of an object, as displayed on the graphics work station, can be recorded on a 35 mm color film recorder. In the present configuration, this recorder is controlled by a personal computer, to which any image can be transferred through the local computer network. A commercial image processing software also runs on this computer and allows further image enhancement prior to recording. Solid reconstruction of 3-D objects can also be performed using the range data. So far, three solid reproduction techniques have been tried: numerically controlled machine milling, stereolithography and laser sintering. Accurate reproductions have been obtained in the case of a stone mask (Figure 5) collected at Tsimshian village of Kitkatla (property of Canadian Museum of Civilisation), and a lead plaque that marked the burial place of Jesuit martyr Jean de Brebeuf.

With the rapid evolution of color reproduction techniques such as laser color printing and robot painting, it should be possible in the near future to obtain accurate color and shape reproduction of objects at any scale.

Museum Applications

There are a variety of museum applications for the system just described. These include:

- The basic measurement of three dimensional color artifacts and specimens for documentation and display purposes.
- Sharing of information by telecommunications.
- Comparison of the color and shape of an object at different periods of time, for example before and after conservation treatment, before and after a loan for exhibition, or to investigate weathering, deterioration, or changes over time.
- Replication of objects at any scale, reconstruction of missing parts, fabrication of supports.
- Research related to science, artists' techniques and art history.

Conclusion

A system for the acquisition of the shape and color of objects has been described. This technology offers some advantages compared to the more familiar 2-D imaging approach by giving the user the same flexibility with the data file that he would have with the real objects, scenes or subjects, and even more. Application of the technology have already been performed in the museum world.

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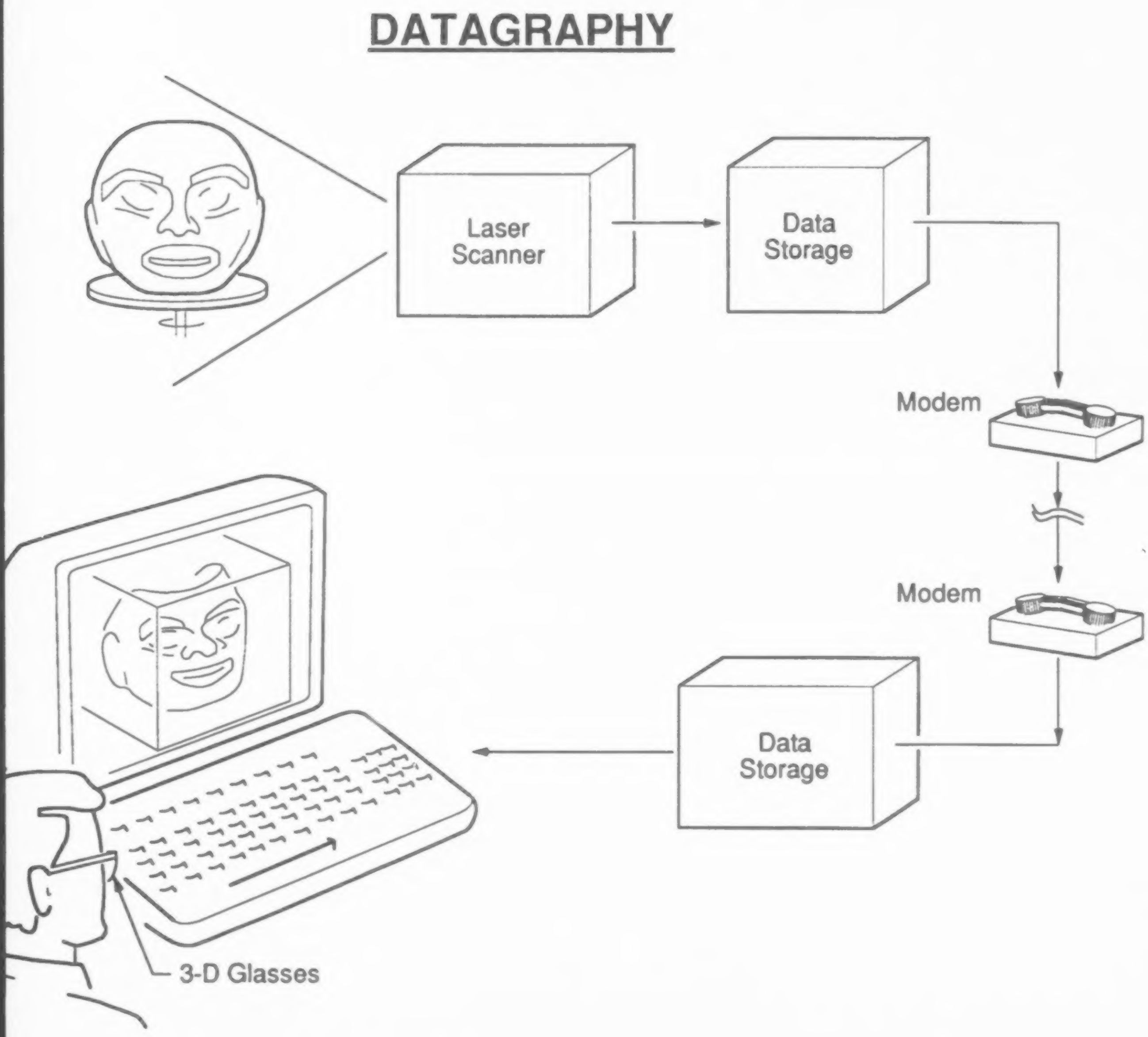
DATAGRAPHY
Laser Scanner
Data Storage
Modem
Modem
Data Storage
3-D Glasses

Figure 1.

Illustration of the system's architecture.

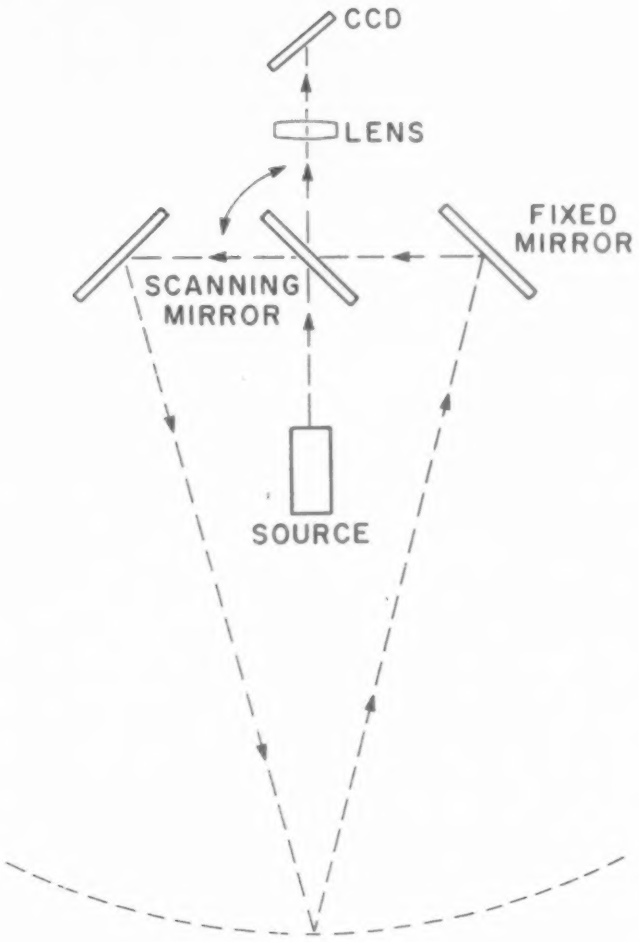
CCD
LENS
FIXED MIRROR
SCANNING MIRROR
SOURCE

Figure 2.

Optical geometry of the sensor head, providing synchronization of both the projection and the detection of a the laser spot.

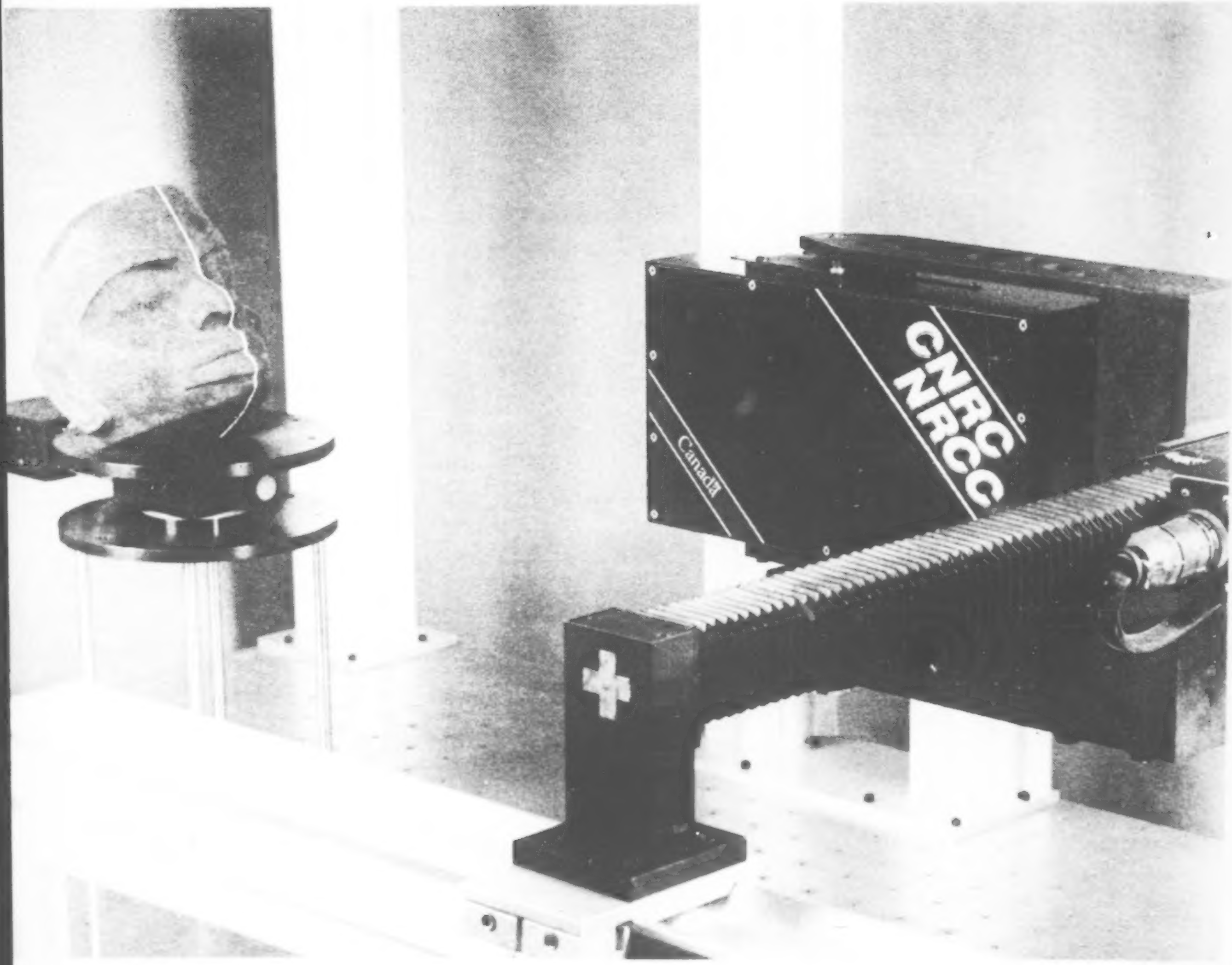

Figure 3.

Acquisition of a stone mask with the laser sensor prototype.

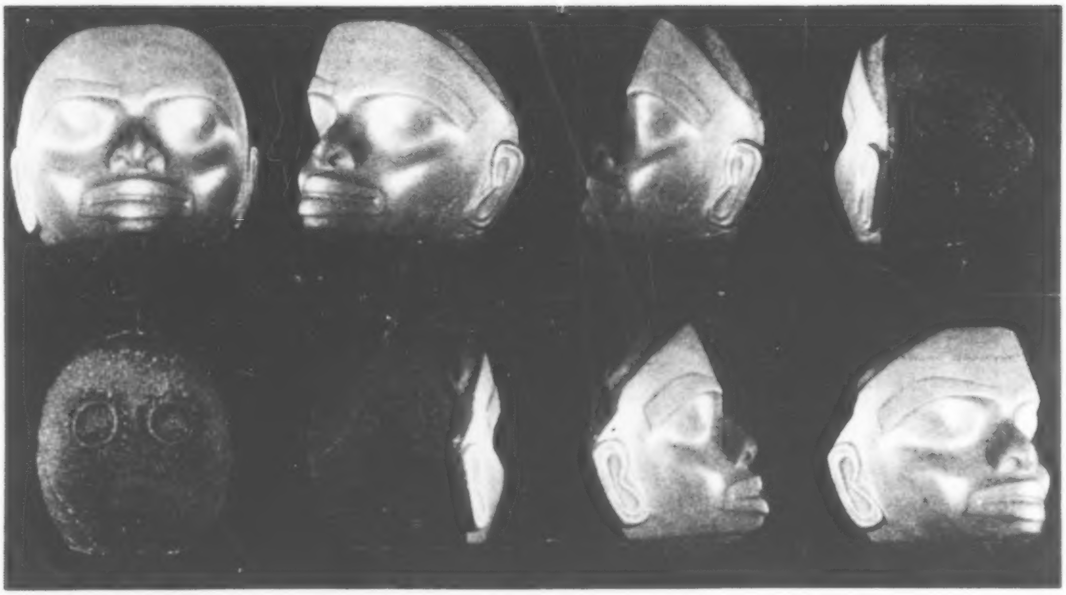

Figure 4.

Reconstructed views of the stone mask, computed at 45 degrees intervals.

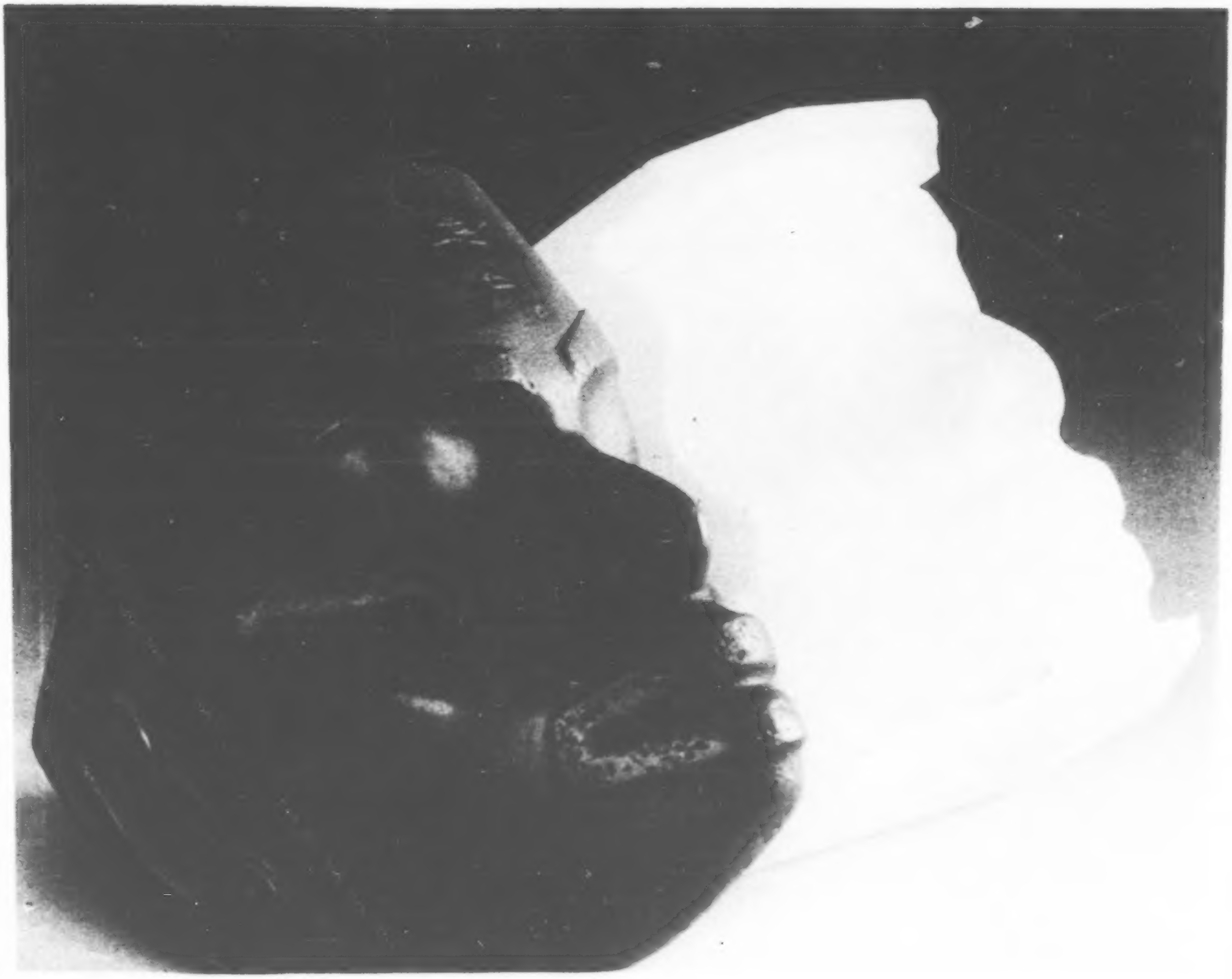

Figure 5.

Hard copy of a stone mask, obtained with NC machine milling, compared with the original object.

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VASARI

A European Approach to Exploring the Use of Very High Quality Imaging Technology to Painting Conservation and Art History Education

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The VASARI project supported by the ESPRIT Programme of the European Community is carrying out applied research in the area of high quality imaging applied to paintings. This paper describes the project with particular attention to the technical results and the potential benefits for Museums and Galleries. A particular feature of the project is its cross-European multi-cultural, multi- site, museum/university/industry nature. VASARI is "user-driven" by its Museum and Art History education partners including the National Gallery, London and the Doerner Institute (Pinakothek, Munich), Direction des Musee de France (Louvre Research Laboratory) and Birkbeck College Art History Department.

I. GGINTRODUCTION

This paper provides a description of the VASARI project with particular reference to the results and targeted benefits for the international museum community. The first VASARI project, of 30 months duration, finishes in December 1991 and it is appropriate to provide for the first ICHIM in Pittsburgh a review of some of the key initial results for its prime immediate target "market": the world's leading Art Galleries and Museums, three of which participate directly in VASARI:

National Gallery Louvre Pinakothek (Doerner Institute)

The paper consists of three main elements beginning in Section II with a description of the origins of the project and its support by the European Technology Research and Development Programme, ESPRIT, described in Section III.

Sections IV and V then present the project as regards both its aims and nature as well as a description in non-technical terms of the approach used.

The first results of the project are described in Sections VI and VII with an assessment of the potential benefits for Museums and Galleries.

II. VASARI Origins

Like any flourishing plant, VASARI has many roots. The deepest and strongest were derived from real user needs. For example, the National Gallery's scientific research on colour change of priceless paintings, as reported in Saunders (1988), began in the 1970s. The second principal "user root" is Birkbeck College's Art History Department "pioneering work" in the area as reflected in its Masters Degree in Art History and Computing, a joint effort with University College, London. Munich's Pinakothek Museum's research group at the Doerner Institut identified the issue of painting damage assessment as a target application area for VASARI. The fourth "user root" was the Louvre's Research Laboratory which had carried out significant Image Processing in the artistic field with the support of the brilliant research group at Telecom Paris' Ecole Nationale Superior de Telecommunication (ENST). The industrial partners generally brought expertise from other areas. For example, THOMSON's Rennes Research Laboratory and its subsidiary SYSECA brought expertise developed primarily for military application. TUEV BAYERN's interest stemmed from its work in industrial testing and quality. SIDAC, the Italian partner, brought experience and expertise in multimedia and electronic publishing in the arts and industry. The consortium was also able to draw upon the work of the scientific and cultural communities, including especially participants in CHArt: Computers and the History of Art. The CHArt Conference in London in 1986 was the venue at which BRAMEUR, a research consultancy already active in European Community Research, participated in order to identify the UK leaders in the field as the first step towards its dream of creating the original VASARI Consortium in 1986, as a contribution to bridge-building in Europe between the Arts and Sciences. After over two years of planning, contract competition, negotiation and preparatory work, the VASARI Consortium began the project in July 1989.

The strong user-driven nature of the Consortium is indicated by the name VASARI, nominally an acronym to meet ESPRIT conventions (Visual Arts System for Archiving & Retrieval of Images) but in fact a suggestion by David Saunders of the National Gallery in honor of Giorgio Vasari, the "Father of Art History".

III. ESPRIT and European Community R & D Support

The European Strategic Programme of Research in Information Technology, ESPRIT, is a ten year US $10 billion programme (in Europe that now means over 10 billion ECUs - European Currency Units or approximately 6 billion British pounds, 60 billion French francs, 18 billion Deutsch-marks, etc.) initiated in the early 1980s to help Europe's computer industry to be competitive with the Japanese and USA. The intitial impetus for ESPRIT was created by the Japanese "Fifth Generation" project.

The main aims of ESPRIT are:

(1) to develop enabling technologies in key areas of Information Technology
(2) to encourage collaboration across Europe
(3) to pave the way to European and International Standards.

By the late 1980s, some 6,000 researchers and engineers across Europe were working in the ESPRIT programme in its four main areas:

Microelectronics Information Processing Systems and Software Advanced Business and Home Systems - Peripherals Computer Integrated Manufacturing & Engineering

The ESPRIT programme is not the only European Community R & D support effort although it is by far the largest. There are also a number of other initiatives all within the FRAMEWORK Programme administered by Community's Directorate General XIII which also includes:

RACE (Telecommunications) including the EVA MUSEUM NETWORK AIM (Informatics in Medicine) DELTA (Learning Technologies) IMPACT (Multimedia Technologies) including the NARCISSE project which works in collaboration with VASARI.

The ESPRIT programme is managed by a relatively small central unit in Brussels but the actual R & D work is carried out by consortia of companies, Higher Education Institutions, and research organisations across the entire European Community. In the second main phase of ESPRIT II in the late 1980s, over 200 different organisations participated ranging from the large electronic companies such as SIEMENS and THOMSON to very small companies such as BRAMEUR with 20 staff.

In order to encourage European industrial collaboration, it is a rule of ESPRIT that each project is carried out by a consortium including at least two industrial companies from two separate EC countries.

ESPRIT supports "pre-competitive, collaborative, research and development" to help achieve the three main aims listed earlier. The financial support consists of 50% funding of approved costs.

It is anticipated that due to the promising results obtained so far by VASARI and the other technology R & D projects in the cultural area, further R & D funding will be provided for this area but this will only be known in 1992 following a very competitive bidding procedure in which typically at least four out of five proposals are rejected.

IV. VASARI: Aims, Partnerships & Resources

From its early planning, VASARI was conceived as a project which would develop technology to help in resolving problems and meeting needs in the real world of the "user" of art and art history. By applying "state of the art" technology but also carrying out user- driven R & D, the VASARI Consortium aimed to:

- demonstrate the practicality of high resolution, colorimetric acquisition, storage and retrieval of images

- develop a prototype demonstrator system for an image database for Computer Aided Learning of Art History
- stimulate and support European IT industry to achieve a leadership position in the niche market of artistic image processing
- increase the level of awareness of this technology in suitable target sectors eg. visual encyclopedias/publishing.

The VASARI partners are as follows:

MUSEUMS & GALLERIES	INDUSTRY
Doerner Institute (Pinakothck) Germany	BRAMEUR UK (Coordinating Partner)
Louvre, France	SIDAC, Italy
National Gallery, UK	SYSECA, France

UNIVERSITIES/HIGHER EDUCATION

Birkbeck College
Telecom Paris/Enst - Telecomms

THOMSON LER, France London University, UK
TUEV-BAVARIA, Germany Ecole Nat. Sup.

The total budget of VASARI is just under US $4 million with a grant from the European Commission of approximately US $2 million. This enabled a peak project staffing of over 30 scientists and engineers and museums specialists in a multi-disciplinary, multi-cultural team spread across four countries and ten sites. The corresponding coordination and management tasks were not inconsiderable.

The VASARI project began in July 1989 and is due for completion in December, 1991.

V. The Technical Approach

The VASARI team took advantage of state of the art systems and software engineering methodologies including in particular:

(1) A structured Prototyping approach using a specially developed version of the "Spiral" methodology
(2) Application of advanced Quality assurance methods at a level appropriate to each loop of the "spiral"
(3) An emphasis on User Requirements and Human Factors Analysis
(4) Development of standards, a vital aspect given the multi-location operations of the project
(5) Use of an "Open Systems" philosophy.

These aspects are discussed briefly in this general survey paper. They will be described in more detail in subsequent papers.

The technical approach taken has been a multi-disciplinary one including:

Museum Conservation specialists Museum scientists Art History specialists Software Engineers Human Factors Specialists/Market analysts

Considerable effort was given to try to balance the different viewpoints, but priority was given to "leading edge user" views particularly at the beginning of the project.

The VASARI "spiral" methodology used is shown in Figure I.1 illustrating how for successive prototypes the following main stages occur:

- REQUIREMENTS ANALYSIS
- DESIGN
- PROGRAMMING/TESTING
- EXPERIMENTAL APPLICATION

This general approach varied by sub-system. For example, five "spiral" cycles were undertaken for the Computer Aided Learning research work.

Quality assurance is a responsibility at four different levels in the project.

(a) Every partner
(b) TUEV-Bavaria for particular aspects such as "mechatronic" testing due to their specialist capabilities
(c) Project coordination
(d) Six monthly ESPRIT Reviews at which a panel of independent experts conduct a full day in depth examination of the project.

User Requirement Analysis, with particular attention to human factors, has been a critical aspect of the project as reported by Granger and Lindermeier (1991). This work benefited enormously from the participation of the three VASARI Consortium members. Their role of "leading edge users" is a vital one in driving the project forward.

Software and hardware standards are important in any system development project; in a multi-cultural, multi-organisation, multi-site project they are a sine qua non. Therefore this was a priority area for the system architectural design of the project leading to:

- selection of UNIX and C to ensured maximum portability of software between partners, i.e., an "open systems" philosophy.
- selection of a standard "platform", a SUN Workstation
- the specification of a number of detailed project standards on topics such as computer image files.

One of the important side-benefits of the project was the opportunity for team members to gain experience of these and other advanced Software Engineering methods.

The project was divided into six major Work Packages as follows:

1. SYSTEM DESIGN

In this Work Package, user requirements were identified and integrated. Human interface requirements and current knowledge of the state of the art were added to produce a comprehensive set of user requirements. A conceptual system design was then developed for a "family" of products of which the main one was the "full" image chain system for production and installation at the National Gallery, London and the Doerner Institute, Pinakothek, Munich.

2. SYSTEM PRODUCTION AND INSTALLATION

"The Work Package is the essence of the whole project; it converts the system design into an installed system" (VASARI Project Technical Proposal). It included:

Computer System Construction Scanner System Construction Physical Environment study Basic Software development General Image Processing Database production System integration

As described earlier the development process used a prototyping approach based on a "spiral" approach. In this Work Package therefore, there was considerable reiteration of the design process.

3. COLORIMETRY AND COLOUR DIFFERENCE MEASUREMENT

The aim of this Work Package was to demonstrate the feasibility of a system capable of measuring colour and small colour differences on the surface of a painting. This work included:

- Spectrophotometric characterization of paintings
- Coding for spectrophotometric images
- Experimentation
- The National Gallery took the lead in this Work Package.

4. MECHATRONIC POSITIONING SYSTEM & SURFACE TEXTURE ANALYSIS

Because of the sophistication of the repositioning system (the high precision "mechatronic" positioning system on which the camera itself is mounted as described later) and its particular importance in damage assessment for example, craquelure analysis, this was given particular attention in this Work Package, the responsibility of the Doerner Institute. Substantial effort was needed to carry out the detailed design (only partly carried out in Work Package 1) and procurement from specialist suppliers. This work includes a major emphasis on identification and analysis of damage to "Art in transit" caused by environmental and physical stress during travelling and during loan.

5. COMPUTER AIDED LEARNING

This Work Package was conceived as a "bottom-up" approach with a PC based sub-system to produce a prototype demonstrator which would include the potential feasibility of linking up to the main high resolution systems developed in preceding work packages. As "Educational User" in VASARI, Birkbeck College took the lead in this Work Package.

Work Packages 6 and 7 are devoted to follow-up Project Planning and Project Management. These include dissemination, the leading example of which is the London Electronic Imaging & the Visual Arts Conference/Exhibition beginning in July 1990 and repeated in July 1991.

These major work packages were broken down into detailed tasks and sub-tasks to permit work allocation between partners and to facilitate management control.

VI TECHNICAL RESULTS

The technical results achieved at the mid-point of the VASARI project centre around the work packages previously described. The main areas cover the acquisition of very high resolution multiband colour sub-images, mosaicing these into a single file, software to calibrate and display colorimetric images on colour CRT monitors and software to analyze colour, colour difference and surface texture.

Successful implementation of these technical results are prerequisites of the VASARI system, which aims to acquire very high resolution colorimetric images which can allow not only the detailed quantitative analysis of changes to colour and surface texture but also the creation of a variety of VASARI subsystems. This is shown in figure II in diagrammatic form. The selection of the level of both spatial resolution and of colour data was closely examined since the multiple reusability of the original data captured by the VASARI scanner system is a key to its long term success.

Conventional colour photographic materials can resolve detail of up to around 100 line pairs/mm. However, when a full-frame general view is taken of a painting the spatial resolution of the object compared with the format of the film material becomes reciprocal. If the object is, say, a painting measuring 10 x 8 inches and the camera is of the same format, then a 1:1 reproduction can be made. Thus the 100 line pairs/mm spatial resolution of the film will record 100 line pairs/mm from the object. However, using such a paradigm, this reciprocal means that the reproduced spatial resolution of the object declines in proportion of its size compared to the film format.

A system which would satisfy both the scientists and art historians requires both accurate colour and high spatial resolution. Many discussions about resolution of detail fall foul of misunderstandings regarding three primary considerations. Firstly, the resolvable detail on the original, i.e. the painting; secondly, the resolution of the imaging device, i.e. the camera format and/or film; thirdly, the resolution of the display device, i.e. a photographic or photomechanical print, a colour transparency or a CRT monitor. Therefore, detailed study was undertaken into the question of an object-independent standard spatial resolution. A standard in the region of 20 pixel/mm was seen as being necessary though this should be seen as a minimum requirement since the examination of micro craquelure requires even higher levels of spatial resolution.

Currently no electronic digital camera, such as a charge coupled device (CCD) camera, can match the overall functionality of a 35mm camera in terms of a single, short (i.e. 1/60th of a second) camera exposure to produce a 3600 x 2400 pixel full colour image. To date two technologies have evolved around CCD. These are the area and the linear CCD array.

1) CCD two dimensional area array cameras have the advantage of geometric stability but are limited in terms of spatial resolution to around 2000 by 2000 pixels.

2) The CCD linear array technology uses a system whereby a linear array is moved by stepper motors across the image plane to produce a "high" resolution image though a single scan has to be a carried out three times in order to acquire the red, green and blue data necessary to create a full colour 24 bit image. However, the spatial resolution of current CCD linear array digital cameras only just surpass that of a 35mm camera and the geometric stability is lower than the array, separate scans being out of registration by as much as one or two pixels. The equivalent pixel resolution of a 10 x 8 inch large format camera is approximately 25,000 by 20,000 pixels. This gap between the ability of conventional photography and that of electronic digital cameras to originate, in a single camera exposure, large amounts of visual data is unlikely to narrow in the forseeable future.

The CCD camera which was finally selected for the VASARI project was the Kontron ProgRess 3200 designed by Dr. Reimar Lenz of the Technical University in Munich. This camera uses a CCD area array with 500 x 290 pixels. High resolution images of up to 2994 x 2320 pixels can be produced through moving the CCD by Piezo-controlled aperture displacement (PAD).

The CCD is mounted between Piezo-ceramic actuators which, when stimulated by an electrical current, move the array in two dimensions by sub micron increments.

In order to create an image of a painting at the standard resolution IT is therefore necessary to position the camera in front of the object and take a series of sub-images (or details) which can then be integrated or mosaiced together by software to produce a single general view. The number of frames is primarily determined by the size of the painting. To mount and move the Kontron camera it was necessary to design a repositioning device which would accurately move the camera in the X and Y axes in front of the painting. This would enable individual camera frames to be captured with as high a degree of geometrical accuracy as possible. This is an important consideration for only highly geometrically accurate frames would enable the subsequent software "mosaicing" to take place. A British firm, Time & Precision of Basingstoke, has designed the first full "Mark II" prototype scanner which was installed in the VASARI laboratory in the National Gallery, London in November 1990. An earlier "Mark I" version provided useful design feedback for "Mark II". Birkbeck College and the National Gallery installed the camera onto the scanner and interfaced it with a UNIX workstation. In the first instance this was done through a 386 PC etherneted to a SUN workstation. A "Mark III" scanner has recently been built in the Doerner Institute in Munich. Mosaicing software using overlap correlation techniques devised by ENST and Birkbeck College images can now mosaic together frames to produce a single, integrated file.

In order to acquire sufficient data for the accurate measurement of changes in colour, studies were carried out by ENST and the National Gallery on methods of using a number of broad band interference filters to modify a standard light source. The conclusion is that using seven or eight such filters should give sufficient information for the measurement of Just Noticeable Difference of one within the CMC (1:c) formula of the Society of Dyers and Colourists Colour Measurement which compensates for the non-uniformity of the CIELAB 1976 colour system. Thus each frame is scanned up to eight times using a specially designed filter wheel placed between the light source and the optical fibres which transmit the light to form a "ring" lighting system.

Accurate display of the colorimetric data on CRT colour monitors has produced other technical results. CRT displays have a restricted colour gamut. The reasons for this are primarily centered on the characteristics of the different types of phosphors used. For a variety of reasons colour CRTs cannot display certain yellows, oranges, browns, magentas and cyans which may be termed the "problem" colours.

The VASARI project has neither the time nor the budget to design and build a new CRT monitor. Therefore the most suitable approach was to quantify objectively the interrelationship between the gamut produced by artists pigments and how this is related to the gamut of a CRT. Test samples of artists pigments were mixed, painted out on a prepared ground and spectrophotometric readings were taken from them. Other measurements were incorporated from other published studies on the colour gamut of artists pigments.

The results of this study indicated that very few traditional artists pigments fell outside the gamut of a standard CRT monitor using the standard P22 set of phosphors. This study therefore proved that it was theoretically possible to accurately display the colour of most artists pigments as RGB signals on a CRT. The problem still remained of how to be able to measure the colour accuracy of a CRT and calibrate it as necessary. Birkbeck College and the National Gallery approached the Belgian monitor manufacturers BARCO to discuss the project's aim and the necessity for "What you see is what you get" (WYSIWYG) colour display. BARCO considered the VASARI project to be examining an area in which it had a direct and significant interest since the company had recently launched a new monitor named the Calibrator.

The Calibrator monitor is designed to reproduce, consistently, very accurate colour through self-calibration using an internal CPU which monitors and corrects as necessary the maximum and minimum luminance of each of the three phosphor sets. The National Gallery London has developed software which accurately displays colorimetric data through changes of luminance rather than either the hue or the chroma.

One of the aims of the VASARI project is to carry out research into computer-aided learning (CAL) visual arts. The first prototype demonstrator was a CDE-ROM working on a standard PC-AT platform produced by SIDAC with another from Birkbeck College. This prototype has colour VGA images of a selection of Dutch paintings from the National Gallery, Alte Pinakothek and Louvre together with a textual database designhed around the data given in the illustrated general catalogue of the National Gallery. Currently work is being carried out on other prototype CAL demonstrators and evaluation of 24 bit colour combined with image compression techniques using standards such as JPEG and de facto standard graphical user interfaces. CD-ROM is seen as being an important short to medium term low-cost delivery platform for the PC environment. However, higher quality low-cost systems are needed for the move towards the ultra-high quality of the full VASARI system. The "quality" versus "affordability" trade-off is a vital one. The multimedia diversity of CD-ROM, CD-I and others constitute a maze of opportunities.

VII. Potential User Benefits

The VASARI project intends to stimulate the use of electronic digital imaging within the visual arts through a combination of technology push and market pull exploiting both a top-down and bottom-up approach. The premise taken is that while it is possible to create images for a CD-I, a videodisc or a colour VGA PC-AT from the VASARI multiband high resolution images, this cannot work in reverse. However, stimulation of the market through comparatively low quality, but above all "affordable" electronic images, acquisition, storing and display devices will play an important role in the development of the various facets which will make up the future of electronics in the visual arts. Reusability of existing datasets should enable considerable cost benefits in terms of a mass domestic consumer market which in turn should raise additional income to help cover the costs of original image acquisition.

The potential user benefits should be very significant across all areas of the visual arts. Within museums and galleries there is a growing need to adopt and adapt information technology for a variety of reasons. Collections management has been dominated over the past few decades by text databases. These frequently could not be easily ported since a wide variety of operating systems and custom built software programmes had been adopted. This situation is improving but now the arrival of digital imaging has added another dimension of possible incompatibility. However, it is believed that the machine independent platform of UNIX and C will mean that the VASARI system is creating images that have a long term future.

Museums collections management covers a number of constituent areas including the scientific study and conservation of objects and the VASARI system aims to produce a highly accurate digital image which will be stable and permanent. These characteristics will enable the detailed monitoring of aspects such as changes in colour and surface texture which may have significant effects on the display and transportation of objects. The creation of sub-images from the original VASARI image files will enable all those professionals involved in the running of museums and galleries to have access to both image and text databases which should have a significant effect on the productivity and efficiency levels.

Museums and galleries are the repositories for a wealth of cultural heritage which is being ever increasingly exploited. For instance the reproduction fees charged by museums and galleries already bring in very significant levels of income. Over the past decade these institutions have received a growing number of visitors which has been reflected in the demand for books, posters, postcards. Electronic digital imaging is already extensively used in reprographics though the use of photographic transparencies as the object to be reproduced persists. Now with the possibilities introduced by digital file transfer through systems such as ISDN, it is becoming feasible to transmit digital image files between a central database and a reprographics house. Thus a printer could call up a museum, log in to the publisher's image database, select an image of the object which is to be reproduced, select the spatial resolution, colour bit-depth and send the file directly to the printing system. The image file, taken directly from the painting would be fully coded so that the reprographics house would merely have to put the file into a software programme which would select the exact ink dot percentage values necessary to reproduce the file using the inks and papers held in stock. Such a system would greatly speed up the process of printing hard copy images and significantly improve hard copy image quality. Furthermore, the financial transactions involved could be easily integrated into such a system.

There was a dramatic increase in the use of electronic public access and point of information systems within museums and galleries during the 1980s. The videodisc remains a popular technology though the digital systems at the Musee d'Orsay in Paris, and latterly the Information Room of the National Gallery London, have pointed to what could be one of the largest areas of potential market growth in the 1990s. Coupled to these systems is the related question of electronic publishing. Several museums and galleries produce commercially available videodiscs though sales in Europe have been extremely limited due to the failure of this technology failing to acquire a significant domestic consumer market base. However, optical storage formats such as CD-ROM, CD- I, CD-PHOTO and CD-TV are opening new avenues for flexible learning whether it be for the professional or amateur and it is likely that by the middle of the decade many museums and galleries will have electronic publications using such formats for sale. Whether they become electronic publishers in their own right, museums and galleries will have new avenues through which to commercially exploit visual and textual data related to their collections.

VII. Conclusions & Outlook

Through a high degree of collaboration and technology exchange the VASARI project has exploited European expertise in museums and galleries, universities and IT industries to create prototype demonstrators which can acquire very high resolution multiband images directly from paintings. The specialist software which has been written to examine colour change and surface texture is of great significance to the scientific study and conservation of elements of our cultural heritage. Furthermore the results which have already been achieved have aroused considerable interest in Europe's commercial and industrial sectors, notably in the reprographic industry and specialist applications of computer-aided design and manufacture where colorimetry and surface texture analysis are paramount.

The CAL CD-ROM and subsequent prototype demonstrators have underlined the feasibility of cheap programmes which exploit a clear relationship to an existing technology base, in this case the PC-AT computer and the domestic CD player. How the PC platform will develop during; the next half-decade is as yet unclear though the sometimes apparently impenetrable jungle of multimedia will, to some extent, determine this.

The first VASARI project did not include aspects such as printed output and telecommunications. This was due primarily to the need to focus efforts in a limited budget. However, it is to be hoped that other research projects will concentrate on such issues.

The dissemination work carried out by VASARI has resulted in over two hundred people attending the first two annual Electronic Imaging & Visual Arts Conference/Exhibition in London in July 1990 and 1991. We hope that the research and the dissemination work will be continued and contribute to practical applications. Visual Arts, aided by the latest technology, have an important role to play in Europe and the World as regards not least in promoting mutual understanding. We hope that subsequent projects will find VASARI a useful stimulant.

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From Prototype To Production In Hypermedia Projects

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Abstract

Many hypermedia projects exist as small-scale prototypes or so-called proof of concept demonstrations. But full-scale projects that are deployed and maintained in production are scarce, because problems can arise at various points in the project life cycle that cause the project to fail. Problems that arise when the project is started include the lack of realistic expectations and the difficulty of assembling a multidisciplinary project team. Problems that emerge during the design and development phases include few published case studies or design guidelines, poor quality or availability of source information, inappropriate and underpowered software technology, and uncertainty about intellectual property issues. Problems at the deployment and maintenance phases include installed base constraints and inadequate methods for maintaining the hypermedia system. Not all of these problems are specific to hypermedia projects, but they conspire with the novelty and immaturity of hypermedia to make hypermedia applications hard to design, develop, and deploy successfully.

Introduction: A Composite Case Study

Attracted by the excitement about hypermedia in the popular press and technical community, an organization decides that links, navigation features, and multimedia will bring enhanced usability to an information management problem that has traditionally been handled in a database or document archive. Since it is the first hypermedia project for the organization, start-up funds are easy to come by. All of the most talented and ambitious researchers and developers in the organization find their way onto the project.

No one keeps track of how much time and effort goes into it, but after a few months a carefully hand-crafted demonstration system or prototype emerges using "Hyper-X". Hyper-X is a highly-touted program that everyone is talking and reading about as a revolutionary software advance.

The prototype system is flashy and compelling on the 19-inch workstation screen. It contains only a tiny amount of the information contained in the proposed full-scale application, but even a casual observer is impressed by how appealing it looks. The colors, graphics and images scanned from documents and books, animation, and sound effects come together seamlessly to create a compelling proof-of-concept.

A senior executive in the organization compares the hypermedia prototype with the original text-based system and declares the Hyper-X version a smashing success. All that remains is to "scale it up" to a production version by converting the remainder of the information to hypermedia.

How you react to this case study depends on where you are in your hypermedia project, or whether you are part of the prototype team or a member of the team tasked to put it into full-scale production. But the prototype is almost certain to fail to make it into production (Glushko, 1991).

Problems for Hypermedia Projects

The case study has followed a typical scenario for hypermedia projects that has set the stage for failure. The problems that face hypermedia projects can be categorized by the phase in the application life cycle at which they arise. Each set of problems represents a barrier to a successful project. Not all of the problems are specific to hypermedia projects, but they conspire with the novelty and immaturity of hypermedia to make hypermedia applications hard to design, develop, and deploy successfully.

In this paper I consider problems of three types: problems that arise when the project is started, problems that emerge during the design and development phases, and problems at the deployment and maintenance phases. Loosely put, these are problems with getting started, getting it done, and getting it to work.

Getting Started

Unrealistic Expectations About Scale and Readiness

Much of what one hears and reads about hypermedia has an artistic or whimsical flavor that presents a captivating vision in which text, graphics, voice, video, and other diverse information sources are much easier to use, "seamlessly integrated" by links with each other, and more entertaining to explore. Hypermedia is often cast as a revolutionary form of writing, posed in stark contrast with reactionary printed text. Hypermedia is said by visionaries to liberate readers from the restrictive confines of the printed page, which herds them through text in a strict, predefined sequence. This perspective is exemplified by authors of literary criticism and interactive fiction, as well as by advertisements for hypermedia programs that suggest that the more clever or creative the link between pieces of information, the better. An early brochure for Apple's HyperCard program juxtaposed a map of Italy with pictures of pasta and a boot.

The potent combination of hype by vendors and enthusiasm in the popular press often leads to unrealistic expectations about how hard it is to design and develop a hypermedia application of realistic scale. Most organizations have no experience base that allows them to make realistic resource and schedule estimates.

The novelty of hypermedia often makes it relatively easy to obtain funds for a small-scale prototype. Many hypermedia projects rely on a combination of internal funding and external sponsorship from computer vendors, government agencies, and foundations. But when the start-up funds run out and the time comes for full-scale development, it is usually much harder to find the resources to pay for the tedious "grunt work" of data preparation and testing, and harder still to pay for ongoing maintenance.

Simple extrapolation from the effort required by the prototype is usually sobering. If a demonstration project takes three months to convert five articles from an encyclopedia into an interactive hypermedia form, how long will it take to convert a thousand articles using the same techniques? Automatic, semiautomatic, or template-based techniques are the only realistic option for large projects, but these are almost never applied during the initial prototyping effort, which usually focuses on user interface concerns. Structural analysis of the information, data modeling, and designing for acceptable performance as the database scales up are not as exciting as user interface concerns, but they turn out to be far more important for projects that aspire to succeed beyond the prototype stage.

Missing Skills on Design and Development Team

Project novelty also makes it easy at first to bring together top-notch people whose efforts benefit from ad hoc inter-organizational cooperation, since everyone wants to be part of an exciting new project at the beginning. Nevertheless, hypermedia projects may require (or at least benefit from) a broader mix of skills than are often readily available. Appropriate skills in a text-intensive project team include:

- Software designers
- User interface designers
- Usability testers and potential users
- Technical writers and editors
- Indexers
- Database designers

Hypermedia projects can require still other talents, including graphic artists and people who understand how to integrate multiple media, sometimes called "art directors". For projects involving the conversion of existing information from printed form, the participation of the author or editor of the original information can be invaluable in understanding the presentation conventions of the existing format. If neither is available, the project should allow additional time to understand the design and design rationale of the existing information. Likewise, the people who run the museum or factory, repair the airplanes, or otherwise are expert in the application area must be involved, or the project runs the risk of building a carefully-designed user interface to the wrong information.

Few organizations or individuals have expertise in more than a few of these areas. Even if the needed mix of skills for a project organization can be assembled by matrix management or by bringing in appropriate consultants, making such an interdisciplinary team work effectively together is no small challenge.

Getting it Done

Few Published Case Studies or Design Guidelines

Because hypermedia is a relatively new design field, there are few detailed published case studies or design guidelines that designers can readily use. Published reports about hypermedia are not representative, typically biased toward small-scale demonstrations or research projects. While hypermedia applications of practical scale have been successfully designed and implemented, in general such projects are not documented in the literature because of resource constraints in development organizations, proprietary considerations, or because they are classified for security reasons.

While there is a growing body of empirical research evaluating particular hypermedia systems or specific design options, this work does not usually generalize well. In addition, what formal experiments have been able to establish is that most of the design choices, when considered in isolation, have only small percentage impacts on system usability (Nielsen, 1989). To complicate matters, sometimes small changes in the user's task or the structure of the hypermedia can lead to conflicting answers about the relative merit of design features (Wright & Lickorish, 1990). Individual differences in users, especially motivational differences, and the effects of different tasks seem to have major effects on system usability. Yet who the users are and the tasks they want to carry out are often not something the hypermedia system designer can control.

Poor Quality or Availability of Source Information

Many hypermedia conversion projects are plagued by the poor quality or availability of source information. Many documents have no digital form, and even when one exists, unless a hypermedia version was planned or contracted for when the documents were created, the existing digital form may not be readily usable.

One common limitation derives from the language with which the digital version of the text was composed or marked-up. The ideal situation is when the markup language is SGML (Standard Generalized Markup Language) or some other language that specifies the logical structure of the document rather than its presentation (Barron, 1989; Goldfarb, 1990).

Optical character recognition (OCR) technology is rapidly improving, and new OCR devices that output text in SGML form are especially promising. Nevertheless, error rates are non- negligible, so proofreading is always required, and the nature of the residual errors in OCR documents makes manual text entry viable unless correct recognition rates exceed 98% (Cushman, Ojha, & Daniels, 1990).

Likewise, images might exist in numerous incompatible formats, and while converting them to a single format is always an option, some of the most common formats are optimized for particular platforms.

Taken together, potential problems with source information make it essential that hypermedia projects carefully investigate source quality and availability before committing to a project schedule. Before converting information to standard formats, the project should consider the range of computing platforms on which the application is likely to be deployed during its lifetime.

Lack of Appropriate Software Tools

Most off-the-shelf hypermedia software is oriented toward creating small amounts of new information and is not well-suited for converting existing information (Alschuler, 1989; Glushko, 1990a; Glushko, 1990b). Demonstration projects often use this software to create expectations about the look and feel of a full-scale implementation, and it often comes as a harsh shock to discover fundamental limitations in the capacity or performance of the software.

User programmability is a prominent feature of this class of software, but the price for a high-level programming language is often poor performance for large amounts of information. Furthermore, most of these programs bundle their user interfaces and the information they present, an architecture that is incompatible with networked applications. Hence, supporting simultaneous users requires duplication of systems and software with corresponding expense and maintenance headaches.

It may be worth waiting for the next generation of hypermedia software that directly supports conversion and that employs a client-server architecture. Alternatively, some database programs or expert system shells may better support hypermedia features than programs that call themselves hypermedia.

If off-the-shelf software must be used for a hypermedia project, it is imperative that any demonstration or proof-of-concept phase carefully address pragmatic issues of scaling up. These include both capacity concerns - can the program manage significantly larger amounts of information with acceptable performance - and resource concerns - does the program imply or impose design methods for defining units, links, or other features that are infeasible when applied on a large scale (Glushko, 1990a, 1990b)?

Legal Uncertainties

In recent years there has been a rash of "look and feel" copyright infringement lawsuits and similar claims for software patents. These legal controversies have arisen because software has been defined both as a kind of "literary work," which makes it copyrightable, and as a kind of machine or method of operating one, which makes it patentable. While these legal analogies may be wrong and may someday be corrected by a new intellectual property law that recognizes the special character of software (Samuelson, 1989b), today software designers and developers are faced with chaos, uncertainty, and legal action.

As unclear as the situation is for software in general, the novel character of hypermedia and hypermedia software raises still more complexities for intellectual property law. For example, if copyright law has different rules for "literary works", "audiovisual works", "sound recordings", and "pictorial works", into what legal category does an interactive hypermedia encyclopedia or a talking book fall? Are new links or notes in a hypermedia system considered "derivative works" under copyright law? These and other issues are not just legal curiosities; they will have considerable impact on the legal protection available and hence the economic viability of hypermedia systems (Samuelson & Glushko, 1991).

The best defense against a copyright infringement claim is to be able to prove independent development, so keeping careful documentation of design decisions is essential. In addition, designs based on experiments or evaluations give the design a "functional" character that narrows the scope of copyright infringement claims. It is best to follow the golden rule when designing a system: Borrow from others no more than you would have them borrow from you. An alternative formulation of this principle can be found in a well-reasoned paper that presents both sides of the look-and-feel debate: Let he who has never borrowed cast the first lawsuit (Samuelson, 1989a).

One aspect of copyright infringement that confronts hypermedia designers and developers is clear and well-known, but new technology has made it easier to break the law. OCR, scanners, digital samplers and video "frame grabbers" are among the wide variety of technology that makes it possible to copy almost anything and incorporate it into a hypermedia system. But having the technology does not imply the right, and a sure way to invite a lawsuit is to assume that it does.

But while it is clearly necessary to obtain the rights to use copyrighted material, the mechanisms for obtaining rights to use copyrighted information are oriented toward the use of works or archives in their entirety. Negotiating the rights to assemble a heterogeneous collection of bits and pieces for a hypermedia application is emerging as a substantial barrier. It is not a coincidence that many hypertext applications have used government documents like standards and regulations that are free of copyright restrictions. For hypermedia applications, publishers and other "content-owners" are being courted by computer hardware, software, and telecommunications companies who are developing business strategies and product lines for multimedia systems..

Getting it to Work

Installed Base Constraints

Hypermedia demonstration projects are often done in research organizations that have advanced technology, including workstations and high-resolution 19-inch monitors. HyperCard on the Macintosh computer is also a very popular environment for demonstration projects.

In contrast, the users for whom full-scale versions of these demonstration systems must be targeted often work with an older or different installed base of computing equipment. This installed base may consist predominantly of IBM AT-compatible processors with small display screens having limited graphics resolution.

This situation often poses a dilemma for hypermedia projects. Advanced technology may be needed to demonstrate the benefits of hypermedia capabilities, but the presentation of these capabilities in the demonstration projects exceeds what the installed base will support. It is essential that the funding or marketing organization promoting the project know the costs and tradeoffs implied by various technology alternatives. Which is more successful, a project that uses less-advanced technology to create lower expectations that can be met, or a project that uses state-of-the art technology that is not readily available for the average user? There is no right answer, but it is essential to ask the question when project goals are being established.

In any case, the installed base slowly changes, so hypermedia designs should be prepared to take advantage of new technology capabilities as they become available. A key consideration is separating the user interface and information management portions of the hypermedia system so that the user interface can be enhanced as the installed base permits it.

Maintaining the deployed application

A hypermedia system deployed in a museum, factory, classroom, or elsewhere inevitably needs to be changed and maintained. Sometimes it is difficult to anticipate the uses and users of a system until it is built, and some tuning of the user interface and content is required. More generally, however, there is no way to get everything right at the outset because things simply change. The museum changes its exhibits, the factory upgrades its machinery, and so on.

Nevertheless, most hypermedia applications to date have been deployed with static and unalterable snapshots of information. Most hypermedia authoring software encourages this practice with separate authoring and run-time versions, with expensive price tags for the former and relatively inexpensive distribution fees for the latter. Hypermedia applications that contain indexes and images that occupy significant space are often attracted by the high-capacity but static storage provided by CD-ROM technology. Furthermore, it is certainly easier to build a static system than to design data structures and user interfaces that enable easy system maintenance.

However, systems that are hard to keep up-to-date fall into disuse. In some hypermedia applications, systems that contain incorrect or inaccurate data can even become dangerous, and the users themselves must assume the primary responsibility for keeping the information "evergreen" (Warren, 1990).

Designing an application for maintenance might also involve redesigning the process by which the information contained in the application is created. For example, hypermedia projects that involve periodic publication of text created elsewhere should define formatting standards and quality control procedures for the organization that produces the information. These measures can lead to substantial improvement in the productivity of hypermedia conversion by enabling the development of automatic conversion software.

Summary

Hypermedia is an attractive vision, but practical hypermedia applications are hard to build. Disciplined approaches to analyzing information, identifying constraints in its structure and in the task environment, and using the appropriate implementation technology are required. Successful hypermedia projects are those that take a cautious approach to problems of scale and that make the right tradeoffs along the way.

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Economic and Design Issues of Large-Scale Multimedia Databases

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Abstract

The aim of this paper is to examine key economic and design issues facing three public institutions now working with multimedia - in particular image databases - and to highlight critical features which need attention while evaluating the feasibility of such a system.

1. Introduction

Museums have a two-fold purpose: to preserve aspects of our cultural heritage for posterity and to make this heritage available to society as a whole.

The transition from a nomadic way of life, or one based on agriculture and trade, to a society based on industry and services makes new demands on those responsible for providing this cultural memory. Our cultural heritage now encompasses not just artifacts such as archaeological remains, tools, works of art and books, but also sounds and images. The twentieth century has brought with it electronic means of recording, distributing and displaying the whole gamut of cultural expression. Electronic media also have a dual role as examples of cultural expression and as the means of disseminating culture in its widest sense. In this paper I should like to focus on the use of multimedia for the preservation of cultural heritage.

Large-scale multimedia databases in museums have been in regular use for more than ten years. Although the number of museums using them is in the hundreds, they are by no means a majority, as can be seen from surveys from North America and Europe.

The term " multimedia" is used here to describe any system where information in the form of text, figures, images, sounds or moving images is displayed on a screen. In some cases this will be a computer screen, in others a television monitor, where the use of computer technology is hidden from the user.

Unlike films or videotapes, which are linear in their structure, multimedia are interactive in the sense that the user can actively make his own way through the material. Each path is unique.

Multimedia, using combinations of text, sound and graphics, are relatively undemanding from a technical point of view, unlike systems containing large numbers of images. For this reason I would like to use three case studies involving images to examine some of the underlying economic and design issues for large-scale multimedia databases.

2. Multimedia Databases - the National Museum of Denmark

The National Museum of Denmark has been active in the use of computer-based image and text databases for the last five years. The Museum itself is organised into eight departments and the collections comprise approximately 1.5 million artefacts.

The basis for this work dates back to 1987 when a private organisation, the Egmont H. Petersen Foundation, provided a grant of some 30 million dollars to the National Museum, on the understanding that this sum would be matched by a grant from the Ministry of Culture, giving a total extraordinary budget of 60 million dollars. The aim was to transform the museum into a modern centre for the preservation and dissemination of knowledge about our cultural heritage. Nearly a fifth of the budget until 1994 was earmarked for a documentation project to automate collection management and to introduce the use of new information technology in exhibitions and services to the public. From 1994 on, the documentation section will be paid for out of existing museum funds.

2.1 Text

Prior to the beginning of the project, collection records were based on hand-written ledgers or file cards. The documentation department had to set up a database system allowing for the decentralised and retrospective registration of objects from all eight departments. The major problems to be overcome were:

- the lack of homogeneity of the paper-based records produced over a two hundred-year period
- whether to continue with the original classification schemes and transfer the content of paper-based records or to limit records initially to a basic register derived from a knowledge of the objects themselves
- the extent to which non-specialist manpower could be used during data input to keep down costs
- the number of data fields to be used for a given object

- ensuring consistent data inputs from different curators.

It is interesting to note that these problems are conceptual and intellectual rather than technical. Carsten U. Larsen, the head of the Documentation Department, reports that design issues, the need for in-service training, and manpower costs for retrospective text entry are by far the most significant challenges to be faced. The other key point is that of costs: given that there are 1.5 million objects at the Museum, the time required for text input is considerable. To date, 385,000 objects have been processed. Figures for the Ethnographical Department indicate that more than 4 minutes were required just to transfer information in its original form to the database. In some cases, several hours' work were needed to correct obvious errors or fill gaps in the records. Using the figure of 4 minutes, and with just over 110,000 artifacts to cover, a minimum of 5 man-years would be required. Text input for the whole collection would require somewhere between 75 and 220 man-years.

2.2 Images

To complement the automation of records, The National Museum also works with images. As the entire west wing of the museum had to be vacated in order to modernize the building, the collections of the Ethnographical Department were put into storage until this work was completed. Before this took place, a local area network was installed, and the department was equipped with computers. Each object was examined to assess its state of repair. Additional information about the object was recorded, after which it was photographed, identified with a label and bar code, packed and put into storage.

Eight teams produced a total of 110,000 35 mm colour slides during this period. Each slide contained a machine-readable identification code paired with the database collection number. The unmounted slides were spliced together in rolls of approximately 50, and transferred to 1"C videotape by DRIVE using a specially developed optical block. While the image (measuring 24 x 32 mm) was transferred, the numerical code in the remaining 4 mm of the frame was fed via a video camera to an optical character recognition unit. The code was paired with the time code of the tape and the information recorded on a computer. LaserDisc videodiscs were produced from the 1"C master tape, and the museum was provided with the address of each object (both the time code on the tape and the frame number on the video disc). This enabled the museum to keep track of each of the objects and to arrange for links between the database and a videodisc player connected to a given terminal. This process has been described in detail elsewhere. Film was chosen as the production medium rather than going directly to videotape or a recordable analogue or digital disc for several reasons:

- film offers extremely high resolution, nine times that of a television image
- the equipment required is easy and cheap to use
- film is a well-known and standardized storage medium allowing for automated transfer to some new medium within the next ten to twenty years as and when required.

As the museum works in the long term, this indirect route via film offers a high degree of security and flexibility for a slightly higher initial cost.

The major problems experienced in the production of the image database concerned quality control and optical character recognition. It is critical that the developed film be checked for adequate exposure and blemishes on a daily or weekly basis. With time, photo diodes can vary in output, or back plates containing this component can be dislodged, slowing the rate at which image transfer can take place from film to master medium.

To reduce such sources of error, DRIVE is producing a similar back plate to produce miniature bar codes on each frame instead of machine readable numbers. The procedure follows European Broadcasting Union guidelines for furnishing film material with time codes. To increase productivity and therefore reduce costs, the 1"C tape system has been replaced by a high quality component recordable video disc system from Sony. Videodisc masters are produced by editing onto Betacam SF (or a digital component format in the near future).

2.3 Multimedia and the public

To date, the records of more than 300,000 artefacts have been computerised and images from two departments - Ethnography and the Resistance Museum - transferred to videodisc. Work is in hand to make the image databases available not only to curators, but also to subject specialists and the general public. Subsets of the material are being used in interactive exhibition systems, the first of which was "Danish Resistance and the German Occupation of Denmark 1940-45." This contains 11,000 photos, posters, and objects and nine video sequences in Danish and English. Although originally conceived for use at the museum itself, the videodisc is now available commercially for use by schools and research workers in Denmark and abroad.

Following the Danish Resistance disc, further systems are being developed: "The Viking Age" (a collaborative effort with the York Archaeological Trust in England to be completed in 1992), an adaptation of "Siulleq", a multimedia database about the culture and people of Greenland to which the National Museums of Denmark and Greenland were significant contributors. A disc covering Mediaeval Church Murals, a prototype of which has been produced by DRIVE and the University of Copenhagen, may also be used when finished.

3. The Proposed National Picture Database at the Royal Library

A second case is that of the Royal Library in Copenhagen, which is the Danish national library. In addition to its collection of books, the Royal Library is responsible for managing some ten million pictures. The lion's share consists of photographs, but there are also significant collections of engravings and water colours.

Preserving such a collection for posterity is no mean feat. The photographic collections contain material from the dawn of photography to the present day, and the conservation of plates and emulsions from the 19th century is a daunting task. Significant parts of the collections are not readily accessible as they were received as donations, often unsorted and without adequate indices.

The picture collections are widely used by historians, local historians and genealogists in addition to publishers, museums, and teachers in Denmark and abroad. Indicative of its use is the fact that, with few exceptions, pictures from the Royal Library are to be found in all illustrated historical publications about Denmark.

The collections also contain sizable quantities of photographs from other parts of the world, including, for example, Denmark's former colonies in the Danish West Indies, and reflect the pattern of contacts between Denmark and the outside world over the last century. The current situation is far from satisfactory and according to the Library management there are three main barriers to be overcome: geographical distribution, procedural matters, and the pictures themselves.

3.1 Geographical distribution

Most of the pictures are unique and can only be seen at the main building near the Danish Parliament. Due to lack of space - common to many other museums and archives - most of the pictures are in storage elsewhere.

3.2 Procedural matters

To find materials in the collection, users have to come in person to the Library during the opening hours of the picture collections, and a picture specialist from the Library is required to conduct a search. The user is present while this takes place, and this makes additional demands of security systems. Approximately 60,000 enquiries regarding photographs, pictures and maps are dealt with each year.

3.3 The pictures themselves

The pictures themselves constitute one of the problems: a search is conducted collection by collection, by and large by thumbing through originals themselves, each of which is kept in a brown envelope with handwritten details on the outside. For many of the collections there is no catalogue or index. A significant proportion of the images are not readily retrievable as they are in storage or are inadequately indexed.

3.4 A National Picture Database - a preliminary study

Following discussions between the Royal Library and DRIVE in connection with the SIULLEQ project about Greenland to which the library also contributed materials, a working party was set up in August 1989 to look into the feasibility of setting up a National Picture Database basedon the collections at the Library. The working party consisted of specialists from the Royal Library DRIVE and other departments of the Danish Broadcasting Corporation, and the head of the Documentation Department of the National Museum as an associate member. The final report of the party dated June, 1990 reviewed the conservation and dissemination issues, provided a brief survey of comparable large-scale image databases and a proposal for a three-year preliminary phase to evaluate and decide on long-term conservation and dissemination strategies.

The report indicated the need to evaluate procedures for the organisation - recording, storage, registration and use of images - on the basis of which the specification for the final database could be based, by completing a cycle from design to production to multimedia products for use in the library and elsewhere, using a thematic selection of the existing collections. The working party indicated that setting up a National Picture Database would be extremely manpower-intensive, and would require funding in addition to that currently provided. On the other hand, the very existence of an electronic catalogue in place of searches using original material would have radical organizational implications. Manpower tied to monitoring visitors and conducting routine searches could be released to increase capacity. Wear and tear of unique originals would be reduced to a minimum, and searches would no longer be limited to the library itself. In line with experience at the National Museum in Denmark, the conservation laboratory of the Norwegian National Library in Rana and the Malm Museums' visual index project, the party recommended evaluating 35 mm still film, 35 mm and 70 mm motion picture film for working masters for images without negatives, supplemented by a high resolution digital format for aging glass plate negatives. The catalogue medium could be either an analogue or digital optical disc, and the choice was to be based on what was most widely accepted in the market place.

The total budget for this phase (work with 115,000 images) was approximately 18 million kroner (nearly 3 million dollars). 81% of the budget covers man-power, and 69% is manpower for database design, text entry and the handling and copying and storage of original materials. Less than 19% of the total figure is devoted to production facilities, and this proportion decreases as a function of the number of images. The preliminary phase of the project is expected to start within the next six months when the necessary funding as been found.

4. The Picture Archives at TELECOM Denmark

TELECOM A/S is part of the Danish Posts and Telecommunications that was privatised at the beginning of 1991. The telecommunications industry has a lengthy history in Denmark, and until last year the only systematic picture library was run by the information department. Photographs and films produced elsewhere in the organisation were produced and used on an ad hoc basis, as is the case in most organisations. TELECOM also has a museums group concerned with telecommunications past and present.

To come to terms with the dual tasks of preservation and dissemination, TELECOM set up a picture archive with the aid of an outside specialist. To date work the picture archive has:

- carried out a preliminary survey of the number and range of pictures, films, and video recordings within the organisation
- drawn up practical guidelines for the selection, use, and storage of visual materials by TELECOM staff
- raised awareness about the need to preserve material of historical interest about Danish telecommunications, and
- commissioned the pilot version of an electronic catalogue based on approximately 5% of the pictures known to exist and which meet minimum preservation requirements.

The purpose of the pilot is to evaluate and cost the procedures to be used for the full-scale project. The biggest uncertainty at present is the cost of establishing the provenance of much of the material and finding people with the necessary background knowledge to be able to describe the content of historical photographs. One idea being discussed is to invite retired employees to local meetings around the country to assist the archive in its detective work. The same idea has been used by our own organisation which occasionally prints historical photographs in the staff magazine which is also circulated to former employees.

The text database for the prototype is currently being implemented and the transfer of the first photographs will have taken place by the time this paper is published. For the prototype, the sample will be sorted by subject, size and format and recorded directly onto a recordable video disc by DRIVE. This allows material to be transferred more rapidly than would otherwise be the case and facilitates the addition of electronically-generated masks for pictures which do not have the 4:3 format of a television screen.

5. Critical Features of Large-Scale Multimedia Databases Needs

The introduction of large-scale multimedia databases often hinges on comprehensive modernization plans of which the computerisation of indices and registers forms a part. In other cases the focus is on conservation issues, and specifically for photographs, the need to distinguish between finding a picture and using it. Improved decentralised access, accompanied by organisational changes at the museum are also commonly-quoted arguments.

Whilst it is true that images on a screen can be no substitute for the real thing, this is not point. At any given moment in time, a small fraction of a museum's artifacts will be accessible: the remainder is in storage.

Image databases come into there own prior to seeing the original. A scholar, curator or a member of the general public has the opportunity to examine and compare in some detail individual pieces not only in the same room but in different collections. This prepares the way for a more efficient use of the originals themselves.

5.1 Finance

Instances of large scale databases being financed out of existing budgets are rare. The National Museum modernization program and the Royal Library project both require funding from extraordinary sources, and the 9 million dollar documentation project which started at the University of Oslo, Norway in February 1991 can only be carried out because subsidised manpower - unemployed staff hired to input text - is available.

5.2 The nature and scale of the task

At a recent conference, a spokesman from Kodak mentioned in passing that approximately 60 billion photographs are taken each year. As is the case with other media, it is clearly impossible to preserve everything for posterity: selection criteria are imperative.

Given the size of existing picture collections such as the Royal Library, hundreds of man-years required to establish an image database. Labour costs as a proportion of total costs increase as a function of the number of items. Decision-makers will therefore have to make trade-offs, being the number of images to be included in the system, the nature and amount of object registration. The critical aspect of object registration is to establish the minimum level of computerisation needed to replace manual records.

Experience from the National Museum shows that it is perfectly feasible to introduce object registration in stages, not only in the museum as a whole but also within the individual collections.

5.3 Conservation issues

Museums are entrusted with the task of preserving aspects of our cultural heritage for posterity - a collective memory. Yet all cultural artifacts deteriorate with time, some faster than others. There is therefore a premium on storage media which will still be intact and accessible well into the next century. As regards images, we are at a critical point in the transition from analogue to digital storage. As far as alphanumerical data is concerned, the transition is complete, whereas this is not yet so for sound and images. Images represent the biggest difficulty, as there are no universally accepted digital formats which offer the same combination of resolution, contrast, cheapness and longevity as film. It is likely therefore that film will continue to be used as an intermediate high-resolution format for the rest of this decade while the battle between analogue and digital storage in the outside world has been settled. If the multimedia database is required for an electronic catalogue or exhibition purposes only, the material can be transferred in automated systems to the delivery system currently in use.

5.4 Computerisation of text inputs associated with images

There is a wide range of taxonomies and classification schemata in use at museums around the world. While data covering the provenance and the physical aspects of an image do not represent insurmountable difficulties, the content is often context-specific, and the context evolves in line with our conceptions of the past. There is therefore a premium attached to minimum levels of computerisation to facilitate exchanges between museums. If this information is not already in machine-readable form, it will consitute one of the major expenses in any database project.

Using Standards to Facilitate Access and Reuse of Museum Information

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Abstract

Standards for dealing with electronic records must be selected based on a careful analysis of user requirements. These requirements must take into account the long range goals of the larger community. For any particular museum this larger community could include archives and libraries, as well as other museums and the patrons of the museums. Consistent use of standards among members of the museum community would facilitate the interchange of information among systems. Further, standards allow the reuse of information. This reuse may be for the same or different purposes.

This paper presents a framework for determining the needed standards for museum records management. Although options are discussed based on the Open System Environment, these are not a predetermined set of standards. The goal of this paper is to help a particular user community select appropriate standards.

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1. Requirements of the Museum Community

A thorough understanding of user requirements is necessary before an efficient information system[2] can be designed. Design of the system includes the selection of hardware and software that meets the needs of the users for in-house information, as well as for data interchange requirements with other systems. This data interchange should be "application, implementation, system and vendor independent'[Com91, page 2].

Analysis of the tasks performed by museum professionals would provide a list of the resources and tools needed to perform each task. From this, a requirements model could be formulated.

1.1 Developing a Requirements Model

The objective of developing a model showing all the requirements of an information system for museums is to present a broad picture showing the information flow, how the information is reused, and the links among the components of the system. Some of the museum tasks are concerned with accession, documentation, access and storage, deaccessioning, lending, and preservation. These tasks need to be expressed as specific steps including input and output requirements.

For example, to accession an object, the object must be available along with a database and a set of measurement devices. Specifically, when an object is accessioned, the object is thoroughly described, usually by filling in fields in a database. These fields include descriptive data, as well as management data. Concurrently with the description the object is analyzed. The goal is a complete record of the object, placing it in its historical setting. Scientific analysis may be made of the material. Documentation includes photographs and drawings and any information available as to when and where the object was found and a record of where it has been since its discovery. Based on this analysis, the object is fit into the museum collection, both physically and conceptually. This "conceptual fitting" could cause major changes in historical thinking if the object presents new and/or unexpected evidence. Other information base records and collection catalogues might require revision and it would be important to publish the new material evidence to open the area for further research.

In developing the requirements model, the process for each task must be annotated in great detail with all the options cited. Further, terms must be carefully defined to assure that their use is completely understood. From this, data flow diagrams and other representations are generated to give the full picture of what information is needed by each component of the system and how to link the components so that the information is entered only once. With careful planning, the data entered on a template, such as that for the object record, triggers a series of links in the information bases of documents, images, sound tracks, etc. A map of these links can be viewed and modified.

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[2] *Information is used here as "information-as-thing"[Buc91].*

Once the requirements model is determined, a model of the computerized information system must be generated. Some requirements of this system are that all information about each object held by the museum be included, that this information be in easily searched databases, that these databases can be accessed from terminals all over the world, that a variety of surrogates be allowed (text, photo/slide, drawing, video, etc.), and that each museum's system be tied in with those of other museums, universities, libraries, and collectors. Further, books, encyclopaedias, journals, catalogues, etc. should be made available via electronic libraries. At present such "libraries" exist on CD-ROM.

In addition to the more obvious tasks mentioned above, there are other issues which could be facilitated with computer assistance. Some of the administrative concerns that fit in this category are statistics, preservation schedules, and status. For example, the following statistical concerns could be programmed into the system: relative value of each object from an historical perspective, the frequency of "use" of any object whether locally or for loan purposes, and the relative cost of upkeep for any group or type of item. Preservation schedules could be put online to assure their completion on time (e.g., time line for maintenance and requirements for maintenance). Status issues include priorities for weeding or exchange and policies for loan, exhibition, and research. Besides the traditional database access, the researcher could be provided with a video sequence showing the object from various angles, an audio sequence made by the archaeologist who found the object, artificial intelligence in the form of expert systems, etc. In order to facilitate searching and to allow for browsing, a hypertext interface should be available.

2. The Open System Environment

The Open System Environment (OSE) is a conceptual framework[3] that provides a context for user requirements and standards specification. It is shown in Figure 1 in its simplest form [Fis91, page 4]. Within the Reference Model, standards address interfaces between entities and between services and supporting formats across those interfaces. The Reference Model is not a layered model; the application platform provides services to users across both platform interfaces [IEE91, page 20].

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[3] *The Open System Environment concept is being developed by the Systems and Software Technology Division of the Computer Systems Laboratory, NIST.*

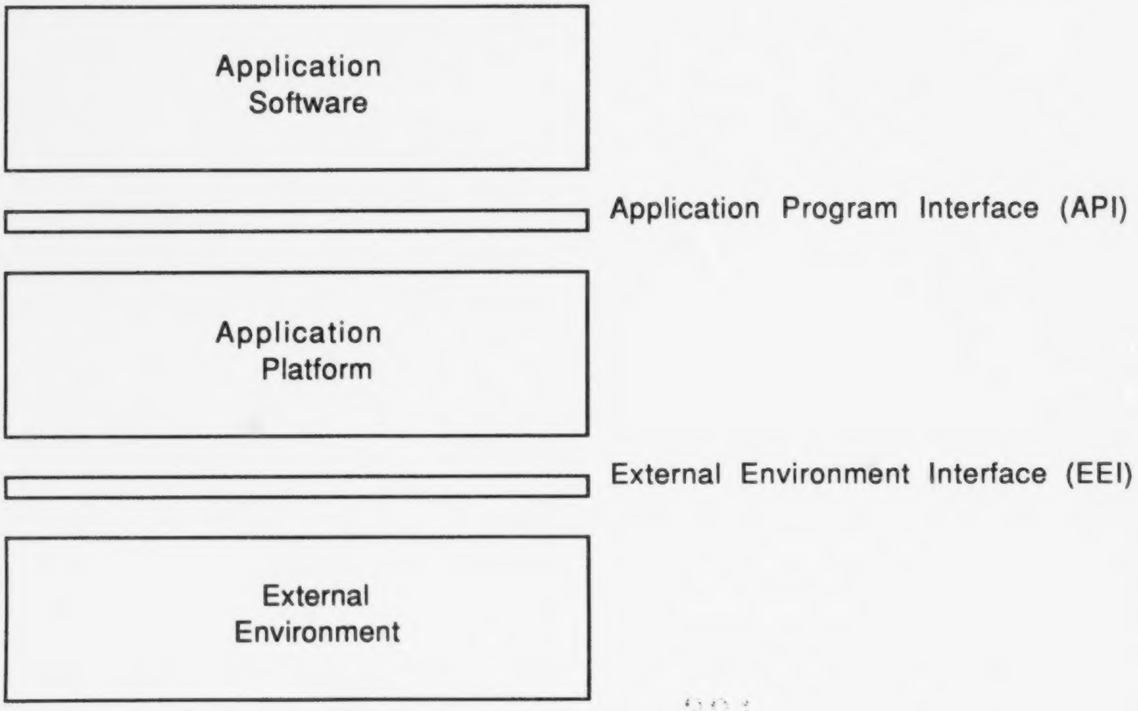
2.1 Application Program Interface

The Application Program Interface (API) contains a number of standards-based interfaces [IEE91, page 24]. The API allows for portability by providing a standard interface between the services of the application platform and the needs of the application software. Portability is the ability to use application software on heterogeneous hardware/software platforms.

2.2 External Environment Interface

The External Environment Interface (EEI) is the interface between the application platform and the external environment across which information is exchanged. The particular services comprise the human/computer interface, the information interface, and the communications interface [IEE91, page 22]. The EEI assures interoperability between devices and the hardware platform. Interoperability of application software operating on heterogeneous hardware/software platforms is necessary for performing some user functions and for data sharing. Specifically, the EEI supports information transfer between the application platform and the external environment.

THE OPEN SYSTEM ENVIRONMENT
REFERENCE MODEL


Application Software
Application Program Interface (API)
Application Platform
External Environment Interface (EEI)
External Environment

3. An Open System Environment for Museums

A museum model based on the generic Open System Environment follows[4]. The examples in the discussion are given to facilitate the development of a concrete model for the reader. They are not intended to represent the design of an actual Open System Environment implementation.

3.1 Application Software

Once the user requirements or needs are specified, the application software can be selected. Sample categories of this software are included in Figure 2. Each application should be capable of communicating and synchronizing with other applications when necessary using communication mechanisms [IEE91, page 21]. It is important that the software selected uses standard interfaces.

Available standards for the services provided by the Application Platform include the following: POSIX for operating system services, X-Windows or higher level Graphical User Interfaces (GUIs) for user interface services, SQL for data management services, SGML, ODA, and CGM for data interchange services, PCTE for programming services, and GKS and PHIGS for graphics services. GOSIP is the Federal Government's profile of standard data communication protocols for network services. (See Appendix A for acronyms.)

The input and output devices for the system, whether CD-ROM, video disc, TV, etc., are determined by the user's choice of software. Figure 2 shows sample devices in the External Environment component of the OSE. Further, the human end-user is an important external entity with which the application platform exchanges information.

3.2 Application Platform

The Application Platform is well-defined in the Open System Environment Reference Model [Fis91, page 7] [MHW90, page 26]. The components are shown in Figure 2. Features needed for each particular application or system would be selected and implemented; not every application platform would provide all features [IEE91, page 22].

4. Using Standards

Standards may be used for many things: nomenclature, data representation, object description, graphics, supplemental documents, etc. The need for consistent use of standards is critical for data interchange among systems and even among components of a single system, and reuse of information.

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[4] *This concept is developed in [Mol91].*

Standards provide "consistency over time of a single application, uniformity throughout an institution, the ability to upgrade systems conveniently, the potential of communicating data among systems, and the possibility of making data available to a broad audience"[SP89, page1].

"The Standard Generalized Markup Language (SGML) and the Office Document Architecture/Office Document Interchange Format (ODA/ODIF) are the two most prominent standards for the markup and interchange of electronic documents" [NW91, page 1]. Although not equivalent standards, each is concerned with electronic document interchange. Because each of these standards was developed by a group with specific needs in mind, it is unlikely that they will merge. Therefore, the user must choose the standard more appropriate to his/her needs. Since SGML and ODA/ODIF are likely to be widely used, there will be translators to convert a document from one to the other[5]. However, since translation is an additional step, the user should choose the standard which offers the greatest benefits for the majority of the needs.

5. The Potential for Reuse of the Content Components

An area of concern to the museum community should be that of reusing electronic files. This reuse may be for the same or different purposes. One way to facilitate such goals is by using tags such as might be used in SGML. SGML is a general-purpose language for describing the structure of data. It is a metalanguage although the language created with it is commonly called a document type definition (DTD). A DTD is an ASCII text file describing what elements and in what order and frequency they may occur in a class of documents. A DTD may be thought of as a set of tags and how those tags may be used plus a grammar that constrains interrelationships. SGML documents are interpreted by a parser which first reads and interprets the related DTD [AW90]. Currently there are many products available which aid in SGML tagging. Further, there are well-developed DTDs available, for example that of the Association of American Publishers (AAP) [AAP88] and that of the Text Encoding Initiative (TEI) [SMB90] which is still under revision.

SGML may be used as generic markup with the DTD written to describe data. This markup identifies elements that have specific formats. Secondly, SGML may be structured markup. In this case the markup parallels the logical organization of a document; for example elements might be labeled "title" or "section." Third, SGML may be markup that facilitates database searching. In this case, elements are identified by name such as "vase type I." "This type of markup is the most difficult to create, but where applicable (especially in tables, catalogs and databases) it offers the most potential for electronic processing, because the user can query the database based on its content" [AW90]. More realistically, SGML might be used for small tables embedded in a document or for interchange of information. Where data is in a relational database, SQL would be the appropriate query language.

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[5] *Software has been written at NIST that demonstrates interoperability of ODA and SGML [NW91, page19].*

6. Conclusion

With the rapid development of the computer industry and related standards, users must make decisions which will benefit their long term goals. Users to think about open systems today even though some standards are not yet fully mature.

> An open systems environment is something that must be migrated to; the more pieces already in place, the easier it will get. The trick for users is to choose carefully today so that a system can be flexible enough to change with the wanderings of open systems, and so that migration hassles and costs can be handled over time [Pat91, page 16].

The most important step for users is to make a careful analysis of their needs. Once the analysis is made, selection of software with standard interfaces is undertaken. The platform or hardware necessary to run the various software applications should be the next consideration. Again, care should be taken to select input/output devices which use standard interfaces.

A. List of Acronyms

The following acronyms were used in this paper and are provided here for reference.

API - Application Program Interface
CD-ROM - Compact Disc—Read-Only Memory
CGM - Computer Graphics Metafile
EEI - External Environment Interface
GKS - Graphical Kernel System
GOSIP - Government Open Systems Interconnection Profile
ODA - Office Document Architecture
OSE - Open System Environment
PCTE - Portable Common Tool Environment
PHIGS - Programmer's Hierarchical Interactive Graphics System
POSIX - Portable Operating System Interface for Computer Environments
RDA - Remote Database Access
SCSI - Small Computer System Interface
SGML - Standard Generalized Markup Language
SQL - Structured Query Language

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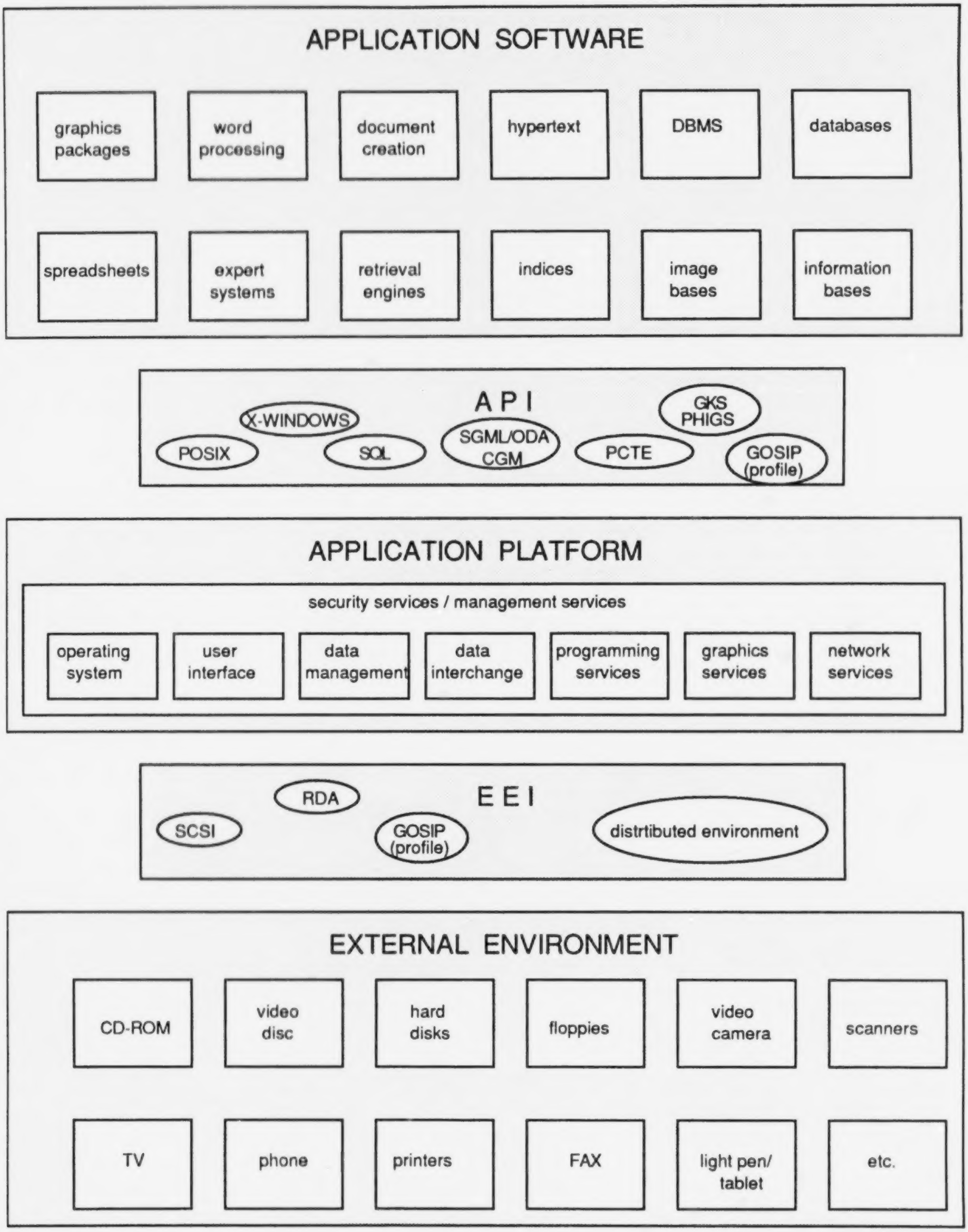
APPLICATION SOFTWARE
graphics packages
word processing
document creation
hypertext
DBMS
databases
spreadsheets
expert systems
retrieval engines
indices
image bases
information bases
API
X-WINDOWS
GKS PHIGS
POSIX
SQL
SGML/ODA CGM
PCTE
GOSIP (profile)
APPLICATION PLATFORM
security services / management services
operating system
user interface
data management
data interchange
programming services
graphics services
network services
EEI
RDA
SCSI
GOSIP (profile)
distrtibuted environment
EXTERNAL ENVIRONMENT
CD-ROM
video disc
hard disks
floppies
video camera
scanners
TV
phone
printers
FAX
light pen/ tablet
etc.

The Cape Dorset Project:

Using Optical Disc Technology to Preserve and Access the Artistic Heritage of an Arctic Community

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McMichael Canadian Art Collection

Earlier this year, after three years of planning and negotiations, a collection of approximately 100,000 Inuit drawings and prints was transferred on loan from the West Baffin Eskimo Co-operative Ltd. in the eastern Canadian Arctic to the McMichael Canadian Art Collection in southern Canada. The arrival of this collection marked the beginning of a multi-year co-operative project between the two organizations designed to ensure the preservation of a unique collection of Inuit art of both national and international significance. An integral part of this project will be recording the entire collection using optical disc technology.

The Co-operative initially approached the McMichael in 1987, regarding support with the care and preservation of their archival collection of Inuit drawings, prints and sculptures. Established in 1959 in Cape Dorset, Northwest Territories, the West Baffin Eskimo Co-operative Ltd. manages the production and sale of locally made Inuit art. The creation of prints, sculptures and other artworks has become an important source of income for the community whose members are encouraged to make drawings at home which are then purchased by the Co-operative. Hundreds of drawings are acquired by the Co-operative each year, and from these 25 to 50 are selected to be translated into prints and included in the annual catalogued collections published at Cape Dorset.

Since the first official set of prints was released in 1959, over 2,000 print editions have been created at Cape Dorset. The archive developed by the Co-operative consists of approximately 100,000 drawings and prints which date from 1957 to the present. The collection contains a comprehensive record of the work of over 80 artists and an example of every print made in Cape Dorset since printmaking began there. Also included are numerous experimental works dating from 1957 and 1958 and approximately 100 sculptures. As such the collection is of considerable national and international importance.

Maintaining the archive as a cultural and historical record of the Cape Dorset Inuit has been a major concern of the Co-operative for several years. The works had been housed in Cape Dorset in a building which was not environmentally controlled and was considered to be a poor fire and security risk. In addition there were no facilities for display, conservation or documentation. The Co-operative approached the McMichael Canadian Art Collection, a major public art gallery in Kleinburg, Ontario, because it had the potential to safely house and properly document the collection as well as make it more readily accessible to a wider audience.

Following negotiations the two institutions signed an agreement in November 1990 and the collection was moved to a specially constructed vault at the McMichael in the spring of 1991. As part of the agreement the Co-operative directors requested that the McMichael house their collection for a minimum of 15 years for the purposes of protecting, documenting, preserving and making the collection available to national and international audiences.

Planning for a collections management strategy for the project was initiated several months before the collection's scheduled arrival at the gallery. The major objectives guiding this process were ensuring that the collection would be properly preserved and documented while maximizing access to the collection for interested parties and exposing it to new audiences. Since the majority of the collection are fragile works of art on paper stored in Solander boxes and because of the large number involved, a major requirement of the strategy became a means of maintaining access to the collection while minimizing the opportunity for damage through handling.

A further factor complicating the documentation and preservation of the collection was the impermanence of certain drawing materials used by the artists. Many of the works are done in felt-tipped pens which have highly fugitive colours. Because of this ephemeral nature it was considered essential that the collections management strategy include a means of permanently documenting these images visually while it was still possible.

The role of optical information systems both as a tool for supporting research while minimizing handling of artworks and as a means of visual documentation had been established previously in the literature and at several institutions. Hence it was decided that the capabilities of these technologies would be investigated to see if such systems could be used to achieve the goals of the project.

Research was undertaken into several different technologies including both analogue and digital WORM (write once, read many) optical discs, eraseable optical discs, CD-I, and CD-ROM. The goal of this study was to determine and compare the versatility, quality, and cost-effectiveness of each system in relation to the intended applications. Each system was evaluated with respect to the following parameters: storage capability (the number of images to be recorded was considerable given the size of the collection and the need for full views as well as details); the ability to produce a hard copy image; the quality of that image; durability of the medium; ability to interface with a textual database; capacity for editing and expansion of records; image retrieval capability; potential for incorporation into interactive programmes for exhibition support; capacity for dissemination of information and visual images on a large scale; and cost.

Following an examination of various configurations of technology, it was determined that investigations would be pursued in the area of analogue WORM optical disc systems. Digital WORM optical disc systems were eliminated because of the large amount of money required to record a single image with the colour resolution required. Given the size of the collection to be documented, this would have necessitated the purchase of a jukebox system which was prohibitively expensive for this project. CD-I technology was eliminated for similar reasons while CD-ROM did not offer the flexibility required.

Research then focussed on a closer examination of products available from two manufacturers of analogue optical disc systems with distribution systems in Canada: Panasonic and Sony. After analyzing the two systems it was found that although there was little variation in price or quality, certain factors favoured the purchase of Sony equipment. Primary among these was that Sony offered a suitable and affordable image management software package that could be adapted to the project's needs. Prior research on other projects involving image databases and discussions with software consultants had indicated that it would be advantageous if basic image retreival software could be purchased since the time and cost involved in software development would be considerable. Sony could also guarantee compatibility between computer hardware and their optical disc storage equipment.

The purchase of the hardware was made possible by a grant from the Cultural Initiatives Program of the Government of Canada. In addition to the software availability the main advantages of this analogue system were as follows: high durability; quick random access to images; large storage capacity - each 12 inch disc has a maximum of 43,500 frames per side; computer interface capability; and a high quality colour image.

To record the works technicians will use Sony's DXC-327 3-CCD video camera mounted in a copy stand configuration. Images will be recorded from the camera onto laserdisc via Sony's LVR/LVS-5000 Laser VideoDisc Recording system. Once images are recorded onto the optical disc they will be played back via the LVA-3500 VideoDisc player which is connected to a PC-compatible computer. Utilizing Sony's Video Guide System software, staff and researchers will be able to connect the images with the textual database. Hard copies of the image will be made using the Sony Colour Video Printer.

The documentation process is still at the formative stage as current efforts are being directed toward developing the database structure. Discussions are also underway with the Canadian Heritage Information

Network in order to determine how the Cape Dorset collection might become part of this important national data network.

As the project progresses a work station at the gallery will enable researchers to access the images and accompanying data with minimal handling of the collection. Discs will eventually be made available to other cultural institutions. It is also anticipated that future exhibitions developed at the gallery will have interactive components utilizing in some form the image/database of the project. An internship programme is also being planned which will enable residents of the Cape Dorset community to develop collection management skills in preparation for the return of portions of the collection to the North should suitable facilities be constructed.

Information Retrieval or Instruction?

Combining the Differing Multi-media Information Needs of Museums, Universities, & Libraries

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Information in museum, university, and library settings is usually designed either to be retrieved (like bibliographic data in an online catalog) or to instruct (like interactive exhibits). Particularly with multi-media information there is little cross-over between these purposes, and up until now most multi-media software has either belonged to the library world or to the world of instructional design and programmed learning.

In the museum world, we see this manifested in the clear distinction between museum education functions (such as interactive exhibitions) which are designed to instruct, and collection management functions which are designed for retrieval. Elsewhere (Besser, 1991), this author has shown how technological changes are likely to provide the groundwork for these two museum functions to converge and combine with one another. Beginning with a collection management system, a common base of knowledge about the collection can be extended both to provide precise information about particular objects as well as to instruct about entire classes of objects.

Within a university setting, combining retrieval and instruction purposes becomes far more complex. A museum is a relatively controlled setting, with a clearly defined collection and domain of knowledge that it seeks to cover. A university, on the other hand, has an incredibly broad collection and (at least in theory) seeks to cover "all knowledge". The museum's task of expanding upon the collection management system to provide instruction appears to be limited enough to be done in incremental steps, each of which can clearly demonstrate some progress towards the eventual goal. A university, on the other hand, is not likely to find that adding instructional material to an online catalog will bring it much closer to combining its library and instructional objectives unless it is willing to put hundreds of person-years into the effort.

Yet, given the right set of circumstances, efforts like this might indeed help a university realize a narrower set of instructional objectives. Given a set of objects owned by a University unit (such as a museum, special library, or archive), the informational records about these objects (eg. cataloging or collection management records) might be enhanced to aid instructional objectives in specific instructional domains. The author has been involved in creating very limited prototypes to attempt this with art historical, architectural, anthropological, educational, and geographic materials at UC Berkeley, Carnegie Mellon University and at the University of Pittsburgh. Many of the bureaucratic and conceptual problems have been outlined elsewhere (Besser & Snow, 1990).

Technological problems include the impact of large image files on storage capacity, networking, and display. Image compression and progressive transmission appear to be the best answers to these problems, but much further research remains to be done on acceptable image display quality.

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A key technical problem is the lack of a standard storage format for the type of information such a system would require. Extensions (such as those expected by the CIMI project) may enhance the MARC record so that it will become sufficiently robust to incorporate collection management systems, but these extensions are not likely to provide for the added information that instructional objectives are likely to require.

Other key technical and technological factors include: how to integrate the display requirements of multimedia into traditional shared-user cataloging systems; how the costs of bit-mapped workstations and the bandwidth of networking are finally becoming affordable enough to begin thinking about shared-user networked applications; and how the development of standards and protocols (such as Z39.50) are beginning to encourage people to explore remote systems.

In the near future, we are likely to see more applications which begin with a set of information about objects residing in museums, archives, and libraries, and enhance these cataloging or collection management records to further contribute to universities' instructional objectives.

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The Micro Gallery

A Multimedia Resource for the Gallery Visitor

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The Micro Gallery, recently installed at the National Gallery in London, is a public-access information system. It provides a comprehensive and richly interconnected illustrated encyclopedia of the collection.

The paper summarizes the choice of technology, the system architecture and design issues. The purpose of the system is to provide a resource to enhance visitors' appreciation of the paintings and to explore the collection in new ways. The function is described with reference to the system's content, structure, and facilities.

Projects in Interactivity in India

Problems and Opportunities

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India is a developing nation with a low per capita income distribution, and its population is spilling over a staggering 850 million. People with diverse social and cultural backgrounds reside in its 23 states and other provinces, speaking as many as 14 (official) different languages and over 200 dialects.

The education system in India is highly textbook-oriented. Right from the Class I level, children are burdened with the most unimaginatively prepared textbooks, which often have pages upon pages of disjointed information which they often are unable to grasp.

The advances of science and technology have not percolated down to the poor. A major contributor to this factor is the lack of proper machinery to communicate the advances of science and technology to the masses. The answer is to demistify the process of disseminating technology to the field.

A leading industrialist, Mr. G. D. Birla, realized this widening gap and decided to set up the country's first science museum, the Birla Museum at Pilani, in the year 1954.

In 1957 came the first major Industrial and Technological Musuem at Calcutta. The National Council of Science Museums was set up by the government of Indian in 1978 and in the short span of 12 years they have established a chain of 14 science museums all over India, with many more under various stages of planning. These museums are at three levels - National, Regional, and District. The National and Regional science museums use "hands-on" exhibits pertaining to fundamental sciences, while some district science centers have exhibits pertaining to localized problems and environmental sciences. These government-run institutions also have a fleet of museo-buses which travel across the country with small temporary exhibition kits which generally emphasize basic science, environmental problems, personal hygiene, and sanitation.

However, it has been largely felt that the mere fulfillment of the program formalities of taking science to the masses has not been very effective. People crowd around the museuobuses out of curiosity and lose interest almost as soon as they encounter a few static models and puzzles and charts. The exhibits often fail to excite the people and often fail to correlate with the intellectual level of the villagers. Each village has to be assesed with a different yardstick. There can be no rigid and uniform standard methods.

In 1982, the electronic medium of television entered into this scenario. The government decided to provide television coverage to 70% of the population. During the year 1984 at least one transmitter was commissioned every day for almost 5 months. And in the last five years this media has been used forcefully to convey crucial socio-economic messages. Environmental awareness, the importance of protecting trees, ground water, building small dams, storing rain-water, mechanized harvesting; powerful social messages on the evils of untouchability, child marriage, equal opportunities for women, the importance of learning how to read and write and the usefulness of science and technology.

Hypermedia and interactive experiments and demonstrations have a hitherto untapped, enormous potential for effective science communication. A careful study and thorough research work, after identifying the needs and levels of various regions, can promise high-gain returns.

Interactivity will be meaningful to greater numbers of people when schools and other educational istitutions, have the infrastructural machinery to take their students to the interactive science centers, which are at present rather too few. In villages, a regular follow-up program, after the mobile demonstration units pay a visit, could prove to be effective, provided the programs are carefully researched and designed in correlation with the immediate and long term problems of the people of that region.

The presentation would also include a case study of a project undertaken by us on these lines in a small village in Rajasthan.

Interactivity for Handicapped Access

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Image Recording is a cooperative project involving the local museum, the County Authority for Work, and the Swedish Folk High School, among other interest groups. (The Swedish Folk High School is a democratic school for adult education that dates from the late nineteenth century.) To make the project worthwhile, we needed to find the place where all these different interest groups, and others, intersected. If we hadn't have been able to find this meeting point, it would have been pointless to try to finance our project. In order to create something truly useful, common ground must be discovered. More pragmatically, it is also necessary to find the place where research and development intersect, and to arrange the product according to the national-international systems.

For our first project we documented the history and tradition of linen production in the area of Halsingland, in northern Sweden. We showed the piece, "Linen in Forsa," at the "VAV91" (Weaving '91) conference in August/September 1991.

We are working with text and image recording as a potential job opportunity for handicapped people. Our aim is to help disabled students to study and practice with Hyper/interactive systems and find applications for use in schools, museums, and in research not only for disabled people, but for the general public as well. Today, many resources are spent on teaching children how to use computers, which of course is worthwhile because these children will grow up and become part of the work force. But we emphasize the need to train adult disabled people. Many disabled people today have never had any computer training at any time in their lives, though they are perfectly capable of learning to use computers. We hope that our students will inspire an interest in interactive media, and we think that many people will have a richer life because of it. Courses are being offered at the Folk High School for the general adult population in how to produce and use interactive media.

A project from 1990, "Growing with Computers," is still being supported and sponsered by the Swedish Board of Education; the aim of the ongoing project is to find out if interactive media really can make daily life easier, particularly for handicapped people. In 1992, we plan to study how interactive media can be used, in a number of different areas - in the Halsinglands Museum, as a tool for disabled people, and as compared to tinteractive processes in the Adult education program. And finally, in 1993, we aim to combine with other text and image recording systems, and to experiment.

Some of the goals of the Image Recording project are to develop the humanities through interactive media, and to find out if interactive media can be useful for Swedish adult education in general.The main goal of the three-year project, however, is to find out how people with a variety of disabilities can take advantage of interactive media. We are studying the potentials for use in daily life, particularly in areas of education.

We also want to dicover whether or not image recording is a good job opportunity for the disabled. Disabled people want to work, but there need to be workplaces that can accomodate them. Museums are good potential employers, needing to have image recording done - a job that could be easily handled by the disabled using computers.

There are some concerns, though. One is that image recording may be too isolated to be a really valuable work experience. Another problem is that most small museums don't have the money to fund this work anyway. So creating an accessible workplace is a problem from the beginning.

The County Authority for Work and a national project are going to fund a workplace for eight young handicapped people. The municipality and the Halsinglands Museum will be the employers. The Folk High School and the county authorities have the locations. Besides these groups, though, other parties are involved: the local history organization, the adult education organizations, and private collectors. Different institutions and organizations will support with money, materials, and systems. For instance, the FRN, the Swedish Coucil of Research, will provide foundations.

A number of questions arise. Will the cooperation work? How well will the different interest groups support each other? How can the Halsingland Museum gain support from the bigger National Museums for classification and computer matters? In what ways will the National Institution for Handicapped Research support a project of this kind? The National Board of Education has already shown interest; in March 1990, a number of teachers took a course in interactive media and gave their opinions about how it could aid handicapped people. What part will this play in the project? Can we fulfill our plans in three years? And what are we going to learn during the journey?

My main concerns are with the disabled people themselves. We are trying to create places for them to enter into the work force. Are these jobs good ones, that fulfill their needs and provide rewarding experiences? Will they be doing something meaningful not only for themselves, but for all people? The good news is that more and more, the answer to these questions is "yes."

Cultural and Technological Resources ast the National Gallery of Art:

Issues in Preparing for Electronic Collaboration

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When a cooperative development plan for a multimedia network between institutions is envisioned, certain issues of the process must be addressed. Linking together the cultural and information resources of the individual institutions and organizations into a usable whole requires agreement to an acknowledged result - a vision of the cultural resources each provides. The national Gallery of Art, is considering future partnerships, is looking closely at its own resources and how to prepare for cooperative development. The area of focus are:

1. Technological Infrastructure

Presently the Gallery has a substantial investment in computer systems that cannot be immediately replaced and must be incorporated into new networking concepts. Planned upgrades of systems can never keep pace with advances in technology. Cooperative development of information systems between institutions has to also mean a partnership with manufacturers and suppliers of hardware and software. Access to and availability of technical resources and support from industry is essential for each partner.

Knowledge of the unique requirements of cultural and academic institutions is not, however, the forte of the computer industry. Confidence in the technical path chosen by an institution must be based on informed decisions built on knowledge from institutional sources. Networking within the academic and cultural community can provide information resources drawn iron experience and contacts developed in earlier projects-experts for advice for critical decision making, user groups for clearinghouses for specific technical information, international museum and academic newsletters on project successes- can all help to educate administrators in making these technical choices.

2.Technology Development

The National Gallery of Art has recognized that technology has crossed a threshold that now provides a medium, through the use of the computer, to make multimedia information system a practical and vital tool for primary research in the visual arts and for production of educational programs.. The quality of the electronic imaging continues to improve. Digital images can now be captured, stored, retrieved, and manipulated on a desktop PC, at a quality approaching 35mm photography. The value of images held be cultural institutions has been proven by the many offers from private industry to "help" disseminate images digitally for a percentage of profits from sales. The hesitation to start the enormous job of digitizing images held by cultural institutions has been eased by the advances in technology that show that there are multiple uses, products, and profits from a digital image - image data bases, CD-ROM's, video disks. and color separations for traditional publishing.

Telecommunications technology now exists to enable high resolution images and data to be sent by satellite anywhere in the world in seconds. Further advances in this field will generate new ideas for uses of multimedia networks. However, serious discussions are required for resolution of data standards and formats, if we are to take advantage of these technological advances.

Traditionally high unit costs for collection and storage of large amounts of data was a deterrent to implementing collaborative projects between public institutions in the past, especially during the recent recession. High volume digital storage devices are now offering more storage space, speed, and economy, allowing cost effective exchange of data between institutions.

3. Cultural Resources

Museums and art galleries have a variety of resources that need coordination both conceptually and technologically to form the multimedia tool that will interface with libraries and universities to form the collaboraTive information base.

Integration of data to form the various components of the Gallery is needed if it is to be made available on a multimedia information network. Library computer systems must become compatible with collection management systems. Photographic quality imaging systems must be incorporated into all areas - with publication, reproduction, and copyright problems recognized. The challenge to the National Gallery now is to integrate the data from thee computer systems of the Department of Conservation, Collection Management, Education, Curatorial Research, Exhibitions, and Photography, as well as the Library and Archives, to create a more comprehensive knowledge base in-house.

The Key to the success of partnerships in creating new multimedia networks is respect for the integrity of the institutions holdings and an appreciation for the institutions view of themselves as a partner and not just a supplier of a commodity. Trying to form an undefined body from distinctive entities invites dissention to the common goal and weakens cooperation.

4 Multimedia Information Networking

Gathering the information from the component departments within the National Gallery of Art is a grew at challenge. The issue of whether now is the time to start seriously looking at true integration of information systems has been answered positively. Technology nor offers a superior advance in the way we view knowledge. Mere technical exercises cannot be a goal. Milestones of success must be components of the plan that clarify the overall view of our goals. Failures we will learn from and will create new challenges. Collaborative extension of institutional resources will more clearly define the difference between information and knowledge

Planning Exhibit and Publication from the First

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Andover, MA 01810

Art museums have always been educating institutions. The meaning of this concept has changed over time and increasingly has come to include the use of media both within the museum and beyond the museum walls. Interactive media are forms of publication that can significantly enhance the museum experience by making an exhibition more accessible both to those who visit the museum and to those who wish to learn and teach about the exhibition from published materials.

Museum exhibitions are the places where people make contact with the work itself. Exhibitions also communicate the point of view or vision of the people who put it together. Museums regard exhibitions as their primary way of making work available to the visitor, and design exhibitions to foster appreciation and education in audiences with widely different levels of understanding. Printed exhibition catalogues have been the principal means of extending the knowledge of the exhibition beyond the requisite reproductions, essays, checklists, interviews, and bibliographies.

Changes in technology make the extended musuem concept increasingly viable and have a discernible impact on museum culture and exhibitions. At present, museums are using slides, film and video presentations, and computers to tie together interactive combinations of these media. It is the quality of this contact and experience which is most directly impacted by changing technologies and central to the extended musuem concept. The task of producing media and designing for interactive museum environments presents some complex problems. Design parameters must include attention to details and issues of present environments both within and outside museum walls. The museum must remain committed to its original mission of preserving the experience of the original work of art and at the same time use the power of available technology to make the art experience as meaningful as possible.

Today many of the films, filmstrips, slide shows and video made to accompany exhibitions are released beyond the museum walls as films or videos, television broadcasts or materials distributed to schools. In addition to exhibition materials, museums and outside producers such as publishing companies release material for an increasingly hungry market eager to learn about art incorporating the use of interactive videodisc and CD-rom. The process of producing these materials both for internal exhibition and for external publication requires careful attention to productions budgets and the amount of financial return, and the multitude of kinds and levels of use interactive materials will allow.

This talk will discuss traditional and new media methods for making art accessible both within the museum environment and outside the museum walls, as well as the design and production of a number of videodisc projects which were incorporated as elements in specific museum exhibitions and then published as interactive videodisc projects for the home market. Included will be explanations of how and why the videodiscs were designed and produced in their present form, how they can act as models, and a description of how they functioned in a specific museum context.

Eadweard Muybridge: Motion Studies

30 Minutes, color, audio 1, CAV videodisc and Hypercard program
Produced and directed by James Sheldon
Eadweard Muybridge: Motion Studies videodisc and Hypercard stack
Copyright 1989 James Sheldon and Addison Gallery of American Art published by The Voyager Company, Santa Monica, CA.

This videodisc along with a catalogue was published in conjunction with the exhibition "Motion and Document - Sequence and Time: Eadweard Muybridge and Contemporary American Photography" produced by the Addison Gallery of American Art.

Harold Tovish: Sculptor

30 minutes, color, audio 1&2, CAV videodisc and Hypercard program
Produced and Directed by James Sheldon
Assisted by Shirley A. Veneema
Produced at Film/Video, The Media Lab, Massachusetts Institute of Technology.
Copyright 1988 James Sheldon and Addison Gallery of American Art published by the Addison Gallery of American Art.

This videodisc along with a catalogue was published in conjunction with the exhibition "Harold Tovish: A Retrospective" produced by the Addison Gallery of American Art.

Ed Paschke: Pigmentata

30 minutes, color, audio 1&2, CAV videodisc and Hypercard program
Directed by James Sheldon
Produced by Alan B. Newman
Copyright 1990 Art Institute of Chicago

This videodisc along with a catalogue was published in conjunction with the exhibition "Ed Paschke: Paintings" produced by the Addison Gallery of American Art.

Visualizing Ancient Greece:
the Sacred Way Project

Philip Smith
New Media Productions Limited, UK

Gary Lock
Institute of Archaeology,
University of Oxford, UK.

The Sacred Way Project is an application of interactive digital multimedia technology to Classical Greek archaeology and architecture. Using the new platform of Compact Disc - Interactive (CD-I), it is intended to produce discs of interest to a wide range of audiences including school and university students, museums and heritage centers and even home entertainment.

The archaeological material to be contained within the Sacred Way discs is to be structured into three main areas. The basic user - experience will be that of a simulated walk through a photorealistic reconstruction of the sanctuary site of Eleusis in the 5th century BC. At any point along the path, the user will be able to access detailed information in a variety of forms on different aspects of the current view. This will include information from one of the three main areas;

a) the actual site of Eleusis itself, with its contingent archaeological problems; history of occupation, features and architecture, finds, stratigraphy, interpretation and excavation history, including The Sacred Way which connected Classical Athens with Eleusis.

b) Every day life and culture in Classical Althens, the city-state which ruled Eleusis during most of Classical Antiquity. There is a large body of information from both archaeology and literary record concerned with Greek religion, education, sport, festivals, politics and beliefs.

c) Modern archaeological methods and theory which result in such information being available today; how archaeologists work.

The presentation will describe the technical and archaeological background to the project and why CD-I technology is felt to be particularly suited to archaeological materials. Both to integrate the richness and variety of the source information and as a powerful tool to aid in the interpretation of complex archaeological situations.

The Museum Education Consortium

A Profile

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History

The Museum Education Consortium, formed in December 1986 through the administrative leadership of the education department of The Museum of Modern Art, originally set out to investigate potential uses of interactive video in museum education. Initially organized as a collaborative project led by the education directors of seven museums - The Art Institute of Chicago, The Brooklyn Museum, The Metropolitan Museum of Art, New York, The Musuem of Fine Arts, Boston, The Museum of Modern Art, New York, The National Gallery of Art, Washington, and The Philadelphia Museum of Art - by 1990 the Consortium became incorporated as a not-for-profit organization with an independent board of directors. Board membershipis currently being expanded to include museum professionals from throughout the country.

Research and Development of Prototype Programs

In the first year, Consortium members familiarized themselves with the technology of interactive, multimedia and with different ways in which such technology had been used in exhibits and education. A design team was engaged to develop a small-scale prototype, a pilot programfocusing on Impressionist and Post-Impressionist Art. This experimental, first phase pilot was completed by the springof 1988. An evaluation period followed in which the two-part program, made up of a mock-up of a teachers' program and a partial working model of an interactive program for museum visitors, was demonstrated and tested with museum audiences in each of the seven participating museums.

The next phase of the Consortium's experimentation began in the summer of the same year launching a two and a half-year research and development effort in which a new team designed and produced prototype programs, one for use by teachers and students in the classroom and the other for museum visitors. Designed to encourage learning by exploration, discovery and comparisons, as well as traditional information retrieval methods, the prototype programs affirm that there are many different levels on which people can appreciate works of art. Using a database of images (stored on a videodisc) drawn from over 147collections worldwide the programs focus on Impressionism and Post-Impressionism, incorporating motion footage, audio source material and documentary images of the period, in addition to stills of works of art. Because one of the primary research goals was technical experimentation, the prototypes incorporated a variety of image capture and display techniques ranging from high definition television (filmed on site in museum galleries) to digitized images. Audience research with museum visitors, teachers, students,etc. has also been a central goal in prototype development. Through formative research valuable insights are being gained to inform future stages of interactive media design.

Next Steps: Tools for Multicultural Education

Since 1989 plans and research have been underway to enable the Consortium to create multicultural education programs for use in schools. Drawing on the resources of numerous museum and private collections throughout the United States, image banks will be assembled to represent the range and diversity of arts and artists shaping our dynamic and pluralistic cultural heritage. Interactive, multimedia programs on art are being developed by the Consortium with other educational partners to generate new curriculum materials for teachers and students.

Currently, the Consortium is being expanded by the addition of new board members - museum professionals and educators from throughout the United States. The restructuring of our organization reflects a renewed commitment to making museum collections more widely accessible to audiences by creating educational tools for the classroom. Interactive, multimedia products designed to be directly useful in multicultural curricula will be created for distribution to schools nationally.

HOLOTHEQUE:

A Multimedia Database System For Ethnology Studies

Shigeharu Sugita
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Research Museum

The National Museum of Ethnology was established in 1974 as an Inter-University Research Institute. The principal functions of the Museum are: (1) to conduct research and investigation in ethnology; (2) to collect, maintain, and exhibit ethnological materials; and (3) through these activities, to deepen the general public's understanding and awareness of the various societies, cultures, and peoples of the world.

Museum Collections

Ethnology or Cultural Anthropology is the comparative study of the societies and cultures of the world's peoples. The scope of investigation covers all aspects of life, such as dwellings, clothing, food procurement and nutrition, history, world view, family and social structures, language, religion, psychology, arts and crafts, and technology, etc. Therefore, our museum collects many kinds of materials, such as artifacts, books, journals, audio-visual tapes/discs, films, slides, photographs, etc. The number of collections is now about 1,600,000 items, and is growing every year by nearly 50,000 items.

Multimedia Database

From the beginning of our museum, we had developed a computerized database system to access all information on different media. Figure 1 is a conceptual illustration of our multimedia database. Figure 2 shows a block diagram of the system. There are five distributed databases: title inventory, artifact image, photo & slide image, video, and book page image. They are located in different places in the museum, and connected by way of optical cable constituting a local area network (LAN). There are two loops of 32 Mbps and 16 Mbps transmission speed. More then 130 terminals or workstations are distributed in the museum, and we can approach directory to any database by way of them through LAN.

Contents of Each Database

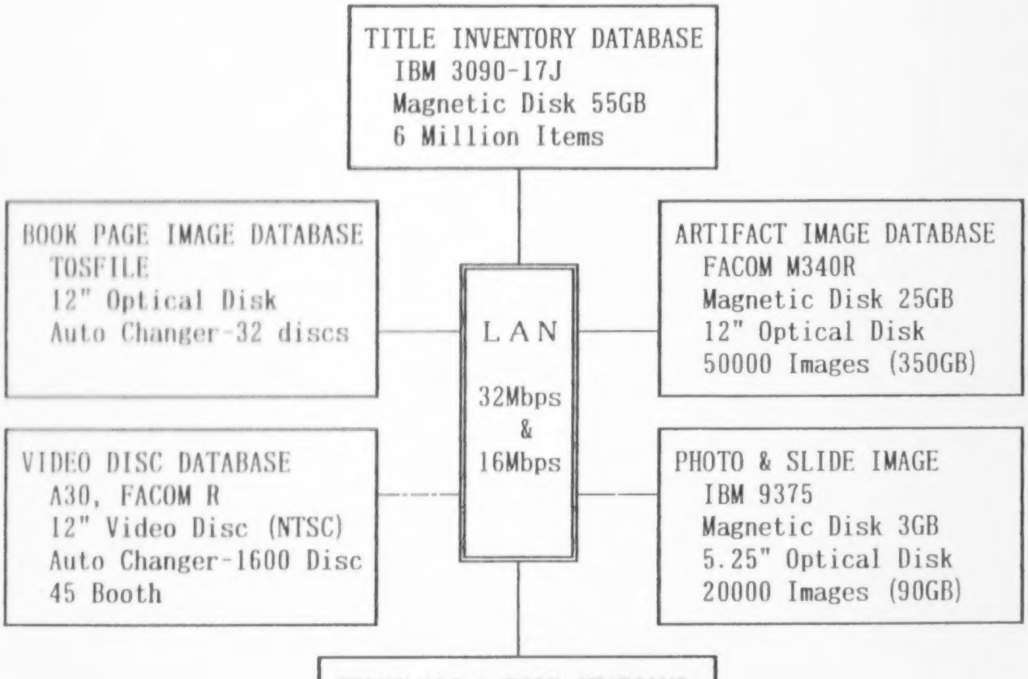
(A) Title Inventory database keeps the descriptive data about books, artifacts, and audio/visual materials. The total number of items in which JP-MARC and LC-MARC data are included is about 6 million. (B)Artifact image database contains digitized artifact data taken by a special system developed by our museum which uses 3 CCD cameras to get images from four views. One artifact generates 7 MB data. Original data are stored on 12" add-on optical disc,and compressed color images are stored on magnetic disk. (C) Photo & slide image database stores digitized slide data taken by HDTV camera. One slide has 4.5 MB data. (D) Book page image database is a so called "electronic filing system" and keeps black and white images of documents. (E) Video disc database, which we call "VIDEOTHEQUE", is an automatic video-disc playback system. This system can contain up to 1,600 discs, and be, p-p-p-accessed from 45 booths in which the user can select any program from among 450 videos through conversation with the computer.

Optical Discs

At present, the amount of image data is about 500GB. Everyday 1GB data are processed and inputted into image database. In order to store these large volumes of data, we use several types of optical discs. There are 12" analog type video discs, 12" add-on typedigital discs, 5.25" add-on type, and 5.25" re-writable MO discs.

Holotheque

We are now designing an integrated multimedia workstation, from which we can retrieve whole related information at the same time, and see on the multi displays. There may be text description, artifact image, slide image, or movie, etc. This system will be called "HOLOTHEQUE," because all (=holo) different information are retrieved at the station as if they are stored in one storage (=theque). At the conference, several slides will be shown, so that the audience can well understand our computer systems and museum activities.


TITLE INVENTORY DATABASE
IBM 3090-17J
Magnetic Disk 55GB
6 Million Items
BOOK PAGE IMAGE DATABASE
TOSFILE
12" Optical Disk
Auto Changer-32 discs
LAN
32Mbps
&
16Mbps
ARTIFACT IMAGE DATABASE
FACOM M340R
Magnetic Disk 25GB
12" Optical Disk
50000 Images (350GB)
VIDEO DISC DATABASE
A30, FACOM R
12" Video Disc (NTSC)
Auto Changer-1600 Disc
45 Booth
PHOTO & SLIDE IMAGE
IBM 9375
Magnetic Disk 3GB
5.25" Optical Disk
20000 Images (90GB)
TERMINALS & WORK STATIONS
PS/55, Mac, PC98, etc.
SUN 3,Spark Station 2
SONY NEWS, LUNA
HP 430t, etc.

Block diagram of the multimedia database
at National museum of ethnology.